453.204 Administrative matters.

453.204-2 Contract reporting (AD-760).

Form AD-760, *Report of Individual Procurement,* is prescribed by the USDA Procurement Reporting System, for reporting contract actions over $10,000 (see 404.601(b)).

453.213 Small purchase and other simplified purchase procedures (AD-744 and AD-838).

(a) Form AD-744, *Purchase Order-Invoice-Voucher,* is prescribed for use as an over-the-counter purchase document (see 413.505-3(a)).

(b) Form AD-838, *Purchase Order,* is prescribed for use as a small purchase/delivery order document (see 413.505-2).

453.270 Request for contract action (AD-700).

Form AD-700, *Procurement Request,* is prescribed as the contract requisition document for contracting activities in USDA.

Subpart 453.3—Illustrations of Forms

453.300 Scope of subpart.

This subpart contains illustrations of Department of Agriculture (AD) forms for use in acquisitions. Forms are not illustrated in the **Federal Register,** or Code of Federal Regulations. Individual copies may be obtained from any USDA contracting activity, or the Director, Office of Operations, Washington, D.C. 20250.

453.303 Agency forms.

453.303-700 Procurement Request (AD-700).

453.303-744 Purchase Order-Invoice-Voucher (AD-744).

453.303-760 Report of Individual Procurement (AD-760).

453.303-838 Purchase Order (AD-838).

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Part IV

Department of Transportation

Federal Aviation Administration

14 CFR Parts 121 and 135

Flight Time Limitations and Rest Requirements for Flight Crewmembers; Proposed Rule

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 121 and 135

[Docket No. 23634; Notice No. 84-3]

Flight Time Limitations and Rest Requirements for Flight Crewmembers

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The FAA is proposing flight time limitations and rest requirements for flight crewmembers engaged in air transportation. This proposal is based on the recommendations of a regulatory negotiation advisory committee composed of persons who represent the interests affected by the flight time rules. This proposal results from a reassessment of the agency's role in regulating flight and rest time in light of current operating conditions and current regulatory phlosophy. The proposal would simplify, clarify, and update the regulations and reduce the need for their interpretation.

DATE: Comments must be received on or before May 14, 1984.

ADDRESS: Comments on the proposal may be mailed in duplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attn: Rules Docket (AGC-204), Docket No. 23634, 800 Independence Avenue SW., Washington, D.C. 20591; or delivered to: Room 915G, 800 Independence Avenue, SW., Washington, D.C. Comments may be examined in the Rules Docket on weekdays, except Federal holidays, between 8:30 a.m. and 5:00 p.m.

FOR FURTHER INFORMATION CONTACT: Lawrence P. Bedore, Project Development Branch, Air Transportation Division, Office of Flight Operations, Federal Aviation Administration, Room 304, 800 Independence Avenue SW., Washington D.C. 20591; Telephone (202) 426-8096.

SUPPLEMENTARY INFORMATION:.

Comments

Interested persons are invited to participate in this rulemaking by submitting written data, views, or arguments and by commenting on the possible environmental, energy, or economic impact of the adoption of this proposal. Comments are also specifically requested concerning the implementation and effective date of the final rule. For example, the FAA would like to know if operators want the option of complying before the mandatory effective date. The FAA proposes to establish an effective date of 180 days after the publication of the final rule in the **Federal Register.**

The comment should carry the regulatory docket or notice number and be submitted in duplicate to the address above. All comments received as well as a report summarizing any substantive public contact with FAA personnel on this rulemaking will be filed in the docket. The docket is available for public inspection both before and after the closing date for making comments.

Before taking any final action on this proposal, the Administrator will consider the comments made on or before May 14, 1984 and the proposal may be changed in light of the comments received. The FAA is allowing only 45 days for comment on this NPRM, because notwithstanding the significance of the issues involved, the FAA believes that this is sufficient time given the length of and the accomplishments of the Regulatory Negotiation Advisory Committee sessions.

The FAA will acknowledge receipt of a comment if the commenter includes a self-addressed, stamped postcard with the comment. The postcard should be marked "Comments to Docket No. 23634." When the comment is received by the FAA, the postcard will be dated, time stamped, and returned to the commenter.

Availability of The NPRM

Any person may obtain a copy of this notice of proposed rulemaking (NPRM) by submitting a request to the Federal Aviation Administration, Office of Public Affairs, Attention: Public Information Center, APA-430, 800 Independence Avenue SW., Washington, D.C. 20591, or by calling (202) 426-8058. Communications must identify the notice number of the NPRM wanted. Anyone interested in being placed on a mailing list for future FAA NPRM's should also request a copy of Advisory Circular No. 11-2 which describes how to apply to be on the mailing list.

Background

The Federal Aviation Act of 1958 (49 U.S.C. 1351 et. seq.) requires the Administrator of the Federal Aviation Administration to issue "reasonable rules and regulations governing, in the interest of safety, the maximum hours or periods of service of aircrew and other employees of air carriers." The rules issued by the FAA under this provision are generally referred to as "flight time limitations." The flight time limitation rules that apply to the major scheduled airlines—those most familiar to the traveling public—are contained in Part 121 of the Federal Aviation Regulations (14 CFR Part 121). These rules contain daily rest requirements for certain operations and weekly, monthly, and annual limits on the number of hours of flight time.

The flight time limitation rules that apply to the fast growing scheduled airlines that operate airplanes of 30 or less seats (commonly referred to as "commuters") and air taxi operations are contained in Part 135 of the Federal Aviation Regulations (14 CFR Part 135). These rules contain daily rest requirements as well as daily limits on the number of hours of flight time but do not contain weekly, monthly, or annual limits. The Airline Deregulation Act of 1978 requires the Administrator, among other things, to "impose requirements upon * * * commuter air carriers to assure that the level of safety provided to persons traveling on such commuter air carriers is, to the maximum feasible extent, equivalent to the level of safety provided to persons traveling" on Part 121 air carriers.

Despite changes in the airline transportation industry over the past 30 years, the rules governing flight time limits and rest requirements have remained virtually unchanged. No safety reasons have been presented which have necessitated changes to the regulations. But the presumed safety of the rules does not necessarily mean that the rules are as effective as they should be or that given recent changes in the industry they will continue to provide an adequate safety standard. There are a number of factors which affect the adequacy of the rules and require that they be amended.

Perhaps the most significant factor requiring amendment of the current rules is that the rules regulating the rest requirements under Part 121 are extremely complicated. Over the 30 years of their existence they have required thousands of pages of interpretations, have sometimes been incorrectly followed by air carriers, and have been difficult to enforce. Thus, a primary aim of this rulemaking is to clarify and simplify the rest requirements for domestic air carriers. This is consistent with Executive Order 12291.

A second significant factor requiring amendment of the rules has been their inflexibility. For example, although under the current rule air carriers are not considered in violation of the rules if flight times are exceeded due to adverse weather conditions or other circumstances beyond the control of the air carrier, an air carrier presently has not flexibility to adjust scheduled rest periods in the event of late arrivals or other factors. If a flight is late, the subsequent flights must often be held up while the flight crewmember receives his scheduled rest. This has resulted in numerous canceled flights as well as delays, and has often required crewmembers to spend extra days away from home. An important objective of this rulemaking proceeding is to eliminate this problem, without derogating safety, by allowing flexibility in scheduling rests so that air carriers, passengers, and flight crewmembers are not unnecessarily inconvenienced.

A third factor affecting the current rules is a change in the character and make-up of the air transportation industry. In the past, most of the domestic air carriers were major companies each employing several thousand crewmembers. However, under deregulation of the air transportation industry, the number and variety of part 121 domestic operators has dramatically increased. The present complexity and variety of operations require that the FAA provide clear and simple minimum safety criteria for all operators. If the present rules are examined as the criteria for safe flight time limitations and rest requirements, some potential weaknesses are apparent. For example, current Part 121 fligh time limits are effective against chronic long-term fatigue because they provide weekly, monthly, and annual flight time limits as well as daily rest requirements for a pilot who flies more than 8 hours in a 24-hour period. But these rules do not provide rest requirements for a pilot scheduled for 8 hours or less flight time in a 24-hour period. Thus, under the current rules an operator can schedule a flight crewmember for 8 hours or less of flight time in a 24-hour duty day and repeat this cycle until the flight crewmember reaches the 30-hour weekly limit. The current Part 121 rule, then, provides no protection against acute short-term fatigue for flight crewmembers scheduled for 8 hours or less of flight time in a 24-hour period. On the other hand, under Part 135, acute short-term fatigue is covered by a 10-hour minimum rest requirement in a 24-hour period and by a flight time limit of 8 hours for a one-pilot crew and 10 hours for a two-pilot crew; but not annual, monthly, or weekly limits exist to protect against long-term fatigue. Under existing Part 135 rules a flight crewmember could fly 10 hours a day with a 14-hour duty day every day of the year, all year.

A fourth factor affecting the current rules, and one related to the changing character of the air transportation industry, has been the growth of commuter-type operations. Some commuter-type operations fall under Part 121 domestic rules while others fall under Part 135 rules. A question exists as to whether either set of requirements effectively covers these comparatively new and growing operations. Thus an additional aim of this rulemaking proceeding has been to study the materials submitted by this industry group and incorporate into the rules standards which will provide a level of safety equivalent to other air transportation operations.

The current rulemaking proceeding is not the FAA's first attempt to solve these problems. For several years the FAA has recognized that the flight time limits and rest requirements need to be clarified and substantively improved in those areas where they are potentially weak. On several occasions the FAA has attempted to correct the flight time limitation problems of both Parts 121 and 135 through rulemaking actions. [1] But because of the complexity of the flight time rules and the economic interests affected, none of the past proposals succeeded in resolving the problems to the satisfaction of the affected parties. Given the importance of these rules in air transportation safety, the FAA, therefore, decided to try an innovative approach which would bring the affected parties together to negotiate a resolution. It was the FAA's hope that this approach would produce a proposal that would at once simplify and clarify the existing regulations, increase their flexibility, and meet all statutory requirements.

Regulatory Negotiation

Regulatory negotiation, as recommended by the Office of Vice President and by the Administrative Conference of the United States, is a procedure by which representatives of all interests affected by a rulemaking fully discuss the issues under conditions conducive to narrowing or eliminating differences and to negotiating a proposed rule acceptable to each interest. In accordance with the recommended procedure, the FAA created an advisory commmittee chartered under the Federal Advisory Committee Act. The committee is comprised of persons representing the diverse interests affected by the flight time rules including persons representing flight crewmembers, air carriers, air taxis, helicopter operators, and the public. At its opening session, the committee was addressed by the FAA Deputy Administrator, the Deputy Secretary of Transportation, the Legal Counsel to the Vice President, a representative of the Office of Information and Regulatory Affairs in the Office of Management and Budget, and the Chairman of the Administrative Conference of the United States. These individuals stated their support for the committee and encouraged the committee to take its charge seriously. In addition, representatives of these offices attended and monitored sessions. The committee met under the direction of Nicholas Fidandis (former Director of Mediation Services of the Federal Mediation and Conciliation Service) who acted as convenor/mediator.

The committee met for 16 days in 1983 (June 29–30, July 11–13, July 25–27, August 8–10, August 22–25, and September 26) and thoroughly discussed the major issues involved in the regulation of flight time limits. Numerous proposals and justifications were drafted by participants and submitted to the committee for review. Copies of all proposals submitted for consideration by committee members and copies of written summaries of each meeting are available in the public docket for this NPRM. Although the committee did not reach consensus on any particular proposal, its deliberations were successful because committee members gave serious consideration to and entered onto candid discussion of the various proposals and justifications submitted to them. Thus the committee succeeded in narrowing the differences among parties and in reaching substantial agreement of some issues. In addition, the committee identified major areas of concern and all parties obtained significant, new information on a subject which has been discussed, without resolution, for years. This document is a notice of proposed rulemaking that reflects the committee's discussion of and agreements on the issues. The document sets forth the FAA's analysis of those agreements and discussions.

The Regulatory Negotiation Advisory Committee also met on February 14, 1984, to review and discuss this proposed rule and preamble. A majority of the committee members recommended that the proposed rule be published in the **Federal Register** as submitted. Several members of the

[1] The following past proposals have to do with flight time limitations and rest requirements:
Notice No. 77–17 (42 FR 43490, August 29, 1977)
Notice No. 78–3 (43 FR 8070, February 27, 1978)
Notice No. 78–3B (45 FR 53316, August 11, 1980)
Notice No. 82–4 (47 FR 10748, March 11, 1982)

committee, however, dissented from this recommendation because they believed that certain issues which have not been resolved to their satisfaction should be addressed further before the proposal is published. The FAA has decided to publish the proposed rule and preamble as submitted to the committee on February 14, but with modifications in the preamble which address the following unresolved issues:

1. The maximum flight time allowed between rests under proposed Parts 121 and 135 scheduled operations;

2. The minimum amount of rest required under proposed Parts 121 and 135 scheduled operations;

3. The maximum weekly, monthly, and annual flight time limits under proposed § 121.471(h);

4. The limitation of "passenger-carrying" in the definition of "scheduled operations" under proposed § 135.261(b); and

5. The lack of a specific response time for deviations under proposed § 135.263(f).

Modifications on these issues have been made in appropriate sections of the preamble.

Comments received on this proposed rule will be reviewed by the committee to determine whether it should recommend that the proposal be modified. Any necessary changes would be negotiated by the committee in the same manner as the NPRM. It must be emphasized that a decision on the final rule is the sole responsibility of the Administrator.

PROPOSED REVISIONS

General Discussion

The proposed rule modifies the current rule in several important ways. First, it reorganizes the regulations according to certain operational differences by creating a separate category in Part 121 domestic rules for commuter-type operations and in Part 135 by separating scheduled operations from non-schedule. Secondly, it adds cumulative flight time limits for all Part 135 operations. The cumulative flight time limits and daily rest requirements for commuter-type Part 121 and scheduled Part 135 operations would be identical. Thirdly, it clarifies the daily rest requirements of Part 121 operators and specific Part 135 operators and adds provisions which correct potential weaknesses in the current rule and which provided scheduling flexibility for air carriers. A complete description and rationale for specific revisions appears below.

Revisions To Part 121 and Part 135 Scheduled Operations

Reorganization to cover "Commuter-type" operations

An issue in this rulemaking proceeding has been the question of which part of the regulations the new commuter air carriers should comply with. The large domestic air carriers clearly fall under Part 121; the small on-demand operators fall under both parts. The dividing line between Parts 121 and 135 is provided by Special Federal Aviation Regulation (SFAR) 38. Operations of airplanes with more than 30 passenger seats or a payload capacity of more than 7,500 pounds must be conducted under Part 121 which contains separate flight time limits for domestic, flag and supplemental (non-scheduled) air carrier operations. Operations with airplanes below these limits must be conducted under Part 135 which at present does not distinguish between scheduled and non-scheduled operations.

While this proposal would continue the 30-passenger/7,500 pound payload distinction as the major dividing line between Part 121 and Part 135 air carrier operations, it would make some additional operational distinctions that would, in effect, make the rules in Part 121 for commuter-type operations identical to those in Part 135 for scheduled operations. The proposed rule would accomplish this in the following way:

(a) Based upon a recommendation of the advisory committee, Part 135 would contain two sets of daily rest requirements and flight time limits, one for scheduled operations and another for non-scheduled operations. The set of daily rest requirements for scheduled operations would be identical to those proposed for Part 121.

(b) Operations of aircraft exceeding the 30-passenger/7,500 pound payload line would continue to be conducted under Part 121, but a separate category would be recognized in paragraph (h) of § 121.471 for operators of propeller driven multiengine airplanes with a passenger seating configuration of 31–60 seats and a payload capacity of 18,000 pounds or less. The flight time limits set forth in pargraph (h) would be somewhat less restrictive than the flight time limits for other domestic operations under that part and would be identical to those proposed for Part 135 scheduled operations (discussed under that section).

The' only minor difference between the two sets of rules would be that scheduled operations under Part 135 would in addition have a daily flight time limit of 8 hours of flight time for one pilot crew. In all other respects the rules would be the same and an operator of aircraft with up to 60 seats having a payload capacity of 18,000 pounds or less could conduct all operations under the identical flight time limits and daily rest requirements.

The proposed creation of this "commuter-type" category is based upon a proposal submitted by the Regional Airline Association (RAA) and endorsed by other committee members that scheduled passenger-carrying operations in aircraft with 60 or less seating capacity be treated, for flight time limitation purposes, as a separate category in both Parts 121 and 135.

According to information submitted by RAA, the basic premise of its request is that "the present regulatory benchmark of 30 versus 31 seats that defines Part 135 operations from those conducted under Part 121 is inappropriate for the flight time rules." Commuter-type operations using smaller aircraft, whether conducted under Part 135 or Part 121, are like each other and substantially unlike longer haul jet operations of the major airlines. Specifically, commuter-type operations are similar in the number of aircraft operated, pilot employed, and routes served; in route distance and pilot flight times, and in operating schedules. The slightly higher flight time limits are balanced by the type of operations typically conducted by this type of operator. The route systems of these operators are such that crewmembers do less flying at night and spend more time at home.

Although the FAA has incorporated the RAA requests into this proposed rule, in view of objections to proposed paragraph (h) expressed at the February 14 advisory committee meeting, the FAA invites comments and statistics on this issue.

It should also be noted that, consistent with present regulatory requirements, Part 135 operators who operate scheduled passenger carrying operations under Part 121 are subject to the domestic air carrier flight time limitations of Subpart Q. Comments are requested as to whether additional regulatory language is needed in this rulemaking proceeding to make this requirement clear.

Revision of flight time limits and daily rest requirements

The weekly, monthly, and annual flight time limits of Part 121 would not be changed by the proposal, except (as mentioned in the previous section) that less restrictive limits are added in

§ 121.471(h) for commuter-type operations. These less restrictive limits are discussed later under "Revisions to Part 135—Scheduled Operations."

The proposed rule makes significant changes in the daily rest requirements under Part 121 and Part 135 scheduled operations. The purpose of these changes is to correct several potential problems inherent in the existing rule.

Under current § 121.471(b), a domestic air carrier may schedule a flight crewmember for more than 8 hours of flight time during a 24-hour period if a rest period is scheduled at or before the end of the 8 hours. The rest period must be twice the number of hours of flight time since the last rest period, but not less than 8 hours. In addition, a flight crewmember who has accumulated flight time of more than 8 hours during any 24 consecutive hours (whether scheduled or not) must be given, upon completion of his assigned flight or series of flights, at least 16 hours of rest before being assigned to any duty with the air carrier.

Several problems exist with these requirements. First, a 16-hour rest given at the end of a series of flights in which a rest of at least 8 consecutive hours has already been given is considered excessive since it amounts to 24 or more hours of rest in a 48-hour period. Second, a 16-hour rest is considered counterrestful because in many cases a flight crewmember will receive his actual rest (sleepful rest) in the first half of the 16-hour period and may therefore no longer be rested by the time he reports for the next duty period. Both of these points were acknowledged by most committee members. Third, and most important, the series-of-flights rule has been misunderstood by some operators to mean that the 16-hour rest must be given at the end of a series of flights that have extended over several days; this is contrary to the agency's interpretation that the 16-hour rest must be given at the end of a series of flights that have occurred within a 24-hour period.

In addition to the above problem, the current Part 121 rule does not have a rest requirement if flight time is 8 hours or less in 24, because the rule was predicated on the belief that fatigue is an issue only in circumstances where flight time is more than 8 hours in 24. Theoretically, this allows a Part 121 operator to schedule a flight crewmember for a 24-hour duty day as long as the total scheduled flight time is 8 hours or less. However unlikely such a schedule might be in practice, the potential for unsafe scheduling should not exist in regulations designed to set a minimum level of safety.

Although present Part 135 does contain a minimum 10-hour rest requirement for scheduled flight time, including flight time of 8 hours or less within any 24-hour period, this requirement has not proven flexible enough to cover some typical Part 135 commuter operations. As a result, at the request of the Regional Airline Association, the FAA issued an exemption that under specific conditions and limitations allows reduction of the rest period to 8 hours.

The proposed rule addresses all of the above mentioned problems. It would clarify and simplify the current regulations by creating reasonable and flexible rest requirements for both Part 121 operations and scheduled operations under Part 135. Proposed §§ 121.471(b) and 135.265(b) would require that a flight crewmember be given the following rest periods in any 24 consecutive hours involving flight time: (1) 9 consecutive hours of rest for less than 8 hours of flight time; (2) 10 consecutive hours of rest for 8 or more but less than 9 hours of flight time; and (3) 11 consecutive hours of rest for 9 or more hours of flight time.

The proposed rule provides flexibility to air carriers in scheduling flights or in rescheduling for flights that have arrived late. Sections 121.471(c) and 135.265(c) would allow the following:

(1) An air carrier could schedule less than a 9-hour rest or could reduce a 9-hour rest by up to 1½ hours if 10 hours of rest is given at the flight crewmember's next scheduled rest.

(2) An air carrier could schedule less than a 10-hour rest or could reduce a 10-hour rest by up to 2 hours if 11 hours of rest is given at the flight crewmember's next scheduled rest.

(3) An air carrier could schedule less than an 11-hour rest or could reduce an 11-hour rest by up to 2 hours if 12 hours of rest is given at the flight crewmember's next scheduled rest.

Thus the proposed rule would eliminate the series of flights problem by establishing a minimum rest requirement in relation to the number of flight hours, and would protect against short-term fatigue while allowing air carriers flexibility in scheduling over a 48-hour period.

In relation to the above proposal, it should be noted that each rest requirement is based on what is commonly referred to in the industry as "release to report." That is, if 8 hours of rest are required, the flight crewmember must be given at least 8 hours free of all duty from the time the flight crewmember is "released" from a duty assignment involving flight time until the crewmember "reports" for the next duty assignment involving flight time. Transportation to or from a hotel is not considered as duty.

It must be emphasized that as a practical matter carriers will not schedule to the limitations permitted by this proposal. For example, the rest requirement for flight time of 8 or more but less than 9 hours is 10 consecutive hours of rest. That 10-hour rest can be reduced for any reason to 8 hours if 11 hours of rest is given at the next scheduled rest. Although the rule technically allows the carriers to reduce the 10-hour rest down to 8, existing practice shows that the carriers would add a "buffer" period to that minimum rest requirement to avoid the need to cancel or reschedule the crewmember's next flight. Thus, few carriers, if any, would actually schedule down to the minimum 8-hour rest. Instead, they would more likely schedule approximately 9 hours of rest leaving additional time in case the flight encountered bad weather or other delays. It must be noted that the minimum rest requirement (in this example 8 hours) cannot *under any circumstances* be reduced further nor can the make-up rest (11 hours) be reduced. If the carriers set the scheduled rest under this example at 8 hours 15 minutes and if there were weather delays resulting in a 30-minute late arrival, the crewmembers would not be able to report to work until they have had the 8 consecutive hours of rest. Therefore, the next scheduled flight would have to be delayed or canceled.

In this connection, it must be noted that the carriers can reduce the scheduling rest for any reason. It can be reduced for scheduling purposes or to accommodate delays in the system caused by weather or other factors. Although the current rules only allow reduction for limited reasons, the proposed change acknowledges that a crewmember who is delayed for bad weather is in the same position as one delayed for "scheduling" reasons. A flight crewmember is not necessarily more "tired" because of the type of delay. This proposed change will increase the flexibility of all parties while assuring that over a 48-hour period each crewmember would receive adequate rest. If the scheduled rest is reduced for any reason, the crewmember must receive a make-up rest. For example, if the scheduled rest was reduced to 9 hours, the crewmember would be entitled to 11 hours of rest at his next scheduled rest and, therefore, would be getting a total minimum of 20 hours of rest during approximately a 48-hour period.

The FAA wants to make it clear that this proposed requirement, as well as all requirements in this proposal, would be strictly monitored and enforced by the FAA.

In addition to the rest requirement, the proposal includes a provision (Section 121.471(a)(4)) which limits flight time to 9 hours between rest periods. This provision has been included to prevent flight crewmembers from accumulating excessive flight hours within short periods of time. This flight time limit plus the weekly flight time limit would prevent flight crewmembers from flying up to the 9-hour limit for more than a few days at a time.

The rest requirement set forth in this portion of the proposal reflects proposals submitted by the Air Transport Association (ATA), a modified version of the ATA proposal issued by the mediator, and a proposal made by the Regional Airline Association. The flight time limit between rest periods reflects with modifications, flight time limits under current Parts 121 and 135. At the February 14 advisory committee meeting which reviewed this proposed rule, flight crewmember organization representatives objected to the 9-hour flight time limit and to the minimum 7½ hour rest allowed under proposed §§ 121.471(c)(1) and 135.265(c)(1). These advisory committee members requested that the 9-hour limitation between rests be reduced to 8 hours and that the minimum rest never be less than 8 hours. They stated that they do not believe these provisions would provide adequate rest. The FAA invites further comments on these proposals including benefits and detriments. Air carriers and flight crewmember organizations should provide comments on how often the 9-hour cap would be reached including the types of schedules, in use or contemplated, to which it would apply. These comments also should discuss the 9-hour cap in relation to the present § 121.471 which, as a practical matter, may limit flight time between rest periods to 8 hours.

Transcontinental Flights

The current requirement under paragraph (b) of § 121.471 for scheduled transcontinental non-stop flights would be eliminated. Under the current requirements for such flights, a crewmember can be scheduled for more than 8 but not more than 10 hours of duty aloft without an intervening rest if the aircraft has a pressurization system and if the flight consists of two pilots and flight engineer. This requirement is outdated since transcontinental non-stop flights no longer take 8 hours.

Revisions to Part 135—All Operations

Organization and Applicability of Sections

At present, all of the flight time limitation requirements in Part 135 are contained in § 135.261. These limits apply to all Part 135 operations whether scheduled or not, whether in helicopters or airplanes, and regardless of any special nature of the operation. The variety of operations conducted under Part 135 has spawned a number of exemptions for seemingly special, but actually somewhat general, types of operations. To accommodate the variety of Part 135 operations, the proposed flight time limitation requirements would be organized into the following categories: (1) Requirements for all operations; (2) scheduled operations; (3) non-scheduled operations; and (4) helicopter emergency medical evacuation service operations.

Section 135.261(b) would define "scheduled operations" to mean "passenger-carrying operations that are conducted in accordance with a published schedule of at least five round trips per week on at least one route between two or more points which include dates or times (or both) that is openly advertised or otherwise made readily available to the general public." Operations within this definition (except those in Alaska) would fall under the requirements of § 135.265. These scheduled operations would be conducted in aircraft with a seating capacity of 30 or less and a payload capacity of 7,500 pounds or less.

This proposed definition would limit "scheduled operations" to "passenger-carrying" operations only. At the February 14 meeting of the advisory committee, a member objected to the proposed rule on the ground that it excluded scheduled cargo operations. The FAA requests further information on the issue of whether cargo operations which meet all other requirements of this definition should be included under "scheduled operations."

Non-scheduled operations (except helicopter emergency medical evacuation services) would be conducted under the rest period and flight time limits of §§ 135.267 and 135.269. These operations would include non-scheduled air taxi operations and commercial operations. Such operations are often seasonal and highly diverse. They include cargo transportation, work crew and executive transportation, surveying, fire fighting, etc. Most of these operations are conducted under contract and are not available to the general public.

The proposal to permit Part 135 scheduled passenger carrying operations in Alaska to be conducted under the rules applicable to non-scheduled operations was made by several members of the advisory committee. The unique characteristics of the Alaskan air transportation system were cited as the rational for allowing Alaskan operators to conduct scheduled passenger-carrying operations under rules designed for non-scheduled operations. Comments and information regarding the safety aspects of this proposal are invited.

General requirements for all operations

Section 135.263 contains requirements that apply either to all operations under Part 135 or to more than one type of operation. There are two significant changes from the present rule proposed in this section. The first is paragraph (e) which would replace current § 135.261(d). Under the present rule is the daily flight time limit of 8 hours in any 24 hours for one pilot crew or 10 hours of flight time in any 24 hours for a two pilot crew is exceeded due to circumstances beyond the control of the certificate holder, the flight crewmember must be given 16 hours of rest before being assigned to further duty which includes flight time. The excessiveness of this penalty would be corrected by paragraph (e) of the proposed section which establishes the following sliding scale for rest periods if flight time limits are exceeded:

(1) 11 consecutive hours of rest if the flight time limitations is exceed by not more than 30 minutes;

(2) 12 consecutive hours of rest if the flight time limitations is exceed by more than 30 minutes, but not more than 60; and

(3) 16 consecutive hours of rest if the flight time limitations is exceed by more than 60 minutes.

In the event that Part 135 scheduled operations exceed the daily flight time limit, this penalty would supersede applicable shorter rest requirements.

The second significant change would be the addition of a deviation authority Proposed § 135.263(g) authorizes the Director of Flight Operations to issue operations specifications authorizing a deviation from any specific requirement of §§ 135.267 and 135.269, the non-scheduled operations, within 2 years after the issuance of this regulation, if he finds that the operator's request is justified and that other conditions provide an equivalent level of safety. The FAA does not believe that the proposal for cumulative flight time limits will be burdensome. However, in an effort to relieve any potential burden of the proposed cumulative flight time limits for non-scheduled operators, this authority would provide an alternative to the exemption process during a 2-year transition period. The intent is to provide limited transition relief and not a permanent exception.

An objection raised at the February 14 advisory committee meeting is that the provision does not specify a time within which the FAA would have to respond to a request for a deviation. A 20-day limit on the response time was recommended by an advisory committee member. The FAA does not believe that a response time limit is appropriate and is unlikely to accept such a time limit on FAA action. Comments are invited.

Revisions to Part 135—Scheduled Operations

As discussed earlier, under the current regulations, no distinction exists between scheduled and non-scheduled operations. All Part 135 operations have a 24-hour flight time limit of 8 hours for a one-pilot crew and 10 hours for a two-pilot crew, and a rest requirement of 10 hours in any 24-hour period. Under the proposed rule, scheduled operations would be separated from non-scheduled. For scheduled operations the daily rest requirements would be identical to daily rest requirements for Part 121 domestic operations, as discussed above under "Revisions to Part 121 and Part 135 Scheduled Operations." In addition, proposed § 135.265 would impose the following flight time limits:

(1) 1,200 hours in any calendar year.

(2) 120 hours in any calendar month.

(3) 32 hours in any 7 consecutive days.

(4) 8 hours during any 24 consecutive hours for a flight crew consisting of one pilot.

(5) 9 hours between rest periods for a flight crew consisting of two pilots.

With the exception of the 8-hour limit, these flight time limits parallel those under § 121.471(h). These figures are similar to the recommendations of those advisory committee members representing scheduled operations subject to Part 135, and are considered to be set at a level that accommodates those operators' scheduling constraints, while requiring a much stricter flight time limit than under present regulations. Under current regulations pilots on two member crews may fly as many as 10 hours a day or 70 hours a week. Under the proposed rule they may fly only 32 hours per week.

The retention of the daily 8-hour flight time requirement for a one pilot crew is necessary because under Part 135 one pilot crews are currently permitted for certain operations, and the FAA considers 8 hours to be the maximum for safe operation of a one-pilot crew without regard to whether there are weekly and other cumulative limits.

Another new requirement for Part 135 operators is the proposed provision in § 135.265(d) that flight crewmembers be relieved of all duty for at least 24 consecutive hours at least once during any 7 consecutive days. This requirement is identical to § 121.471(d) and works together with the weekly flight time limits to prevent the buildup of fatigue in flight crewmembers operations under Part 135.

Revisions to Part 135—Non-Scheduled Operations

Quarterly and Yearly Flight Time Limits

Current § 135.261 contains no cumulative flight time limits. The proposed §§ 135.267(a) and 135.269(a) would impose the following quarterly and yearly flight time limits:

(1) 500 hours in any calendar quarter.

(2) 800 hours in any two consecutive quarters.

(3) 1,400 hours in any calendar year.

The quarterly and yearly flight time limitations are intended to prevent cumulative fatigue while acknowledging that the seasonal operations of a few non-scheduled operators may exceed the weekly and monthly limits proposed in § 135.265.

As used in this proposal "calendar quarter" refers to January–March, April–June, July–September, or October–December.

Quarterly Rest Requirements

In the current Part 135 rules, there is no requirement to provide one 24-hour period of rest in every 7-day period as there is in Part 121. Proposed §§ 135.267(f) and 135.269(b) would require the certificate holder to provide at least 13 rest periods of at least 24 hours in each calendar quarter. While this requirement is not identical to the rest required under Part 121, it will provide adequate rest and still allow flexibility in scheduling 24-hour rests for seasonal and on-demand operations.

Daily Flight Time Limits and Rest Requirements for One- and Two-Pilot Crews

The daily flight time limits of § 135.267(b) are parallel to the present § 135.261(a) with the following exceptions, the phrase "required by this chapter" has been replaced by the phrase "qualified under this part" with respect to the 10-hour flight time limit for a flight crew consisting of two pilots. In effect, this will allow a flight crew consisting of two qualified pilots to fly up to 10 hours in an aircraft which may be operated by a flight crew of only one pilot under Part 135. In addition a new paragraph (c) has been added which allows a flight crewmember to exceed the flight hours of paragraph (b) within a specified duty period.

Paragraph (c) § 135.267 would allow an operator and flight crew to use a regular daily schedule rather than the rolling 24-hour clock. A flight crew could fly the allowed flight time any time during a regularly scheduled duty period which is separated from the next duty period by a regularly scheduled rest period of at least 10 hours. The duty period and the rest period together must total 24 hours. This alternative is intended to give scheduling flexibility to Part 135 operators who use a regular, diurnal cycle as the basis of their operations.

Another difference from the current rule is the addition of flight time limits for augmented crews. These limits, set forth in § 135.269, are discussed below.

Daily Flight Time Limits and Rest Requirements for Three- and Four-Pilot Crews

Since the present rules do not provide special requirements for augmented crews, operations which utilize augmented crews have been operating under exemptions. Proposed Section 135.269(c) incorporates the exemption requirements into the rule. Basically the rule would limit flight time to 8 hours in 24 consecutive hours, but would allow for an extended duty period and extended period aloft if the aircraft is equipped with approved sleeping facilities for the relief pilot. The rule also would require a minimum 12-hour rest after an extended duty period. These regulations would provide an equivalent level of safety while recognizing the benefits of augmented crews for certain operations.

Helicopter Hospital Emergency Medical Evacuation Services

Proposed § 135.271 contains regulations for the helicopter hospital emergency medical evacuation services. These regulations would differ from proposed § 135.267 in that flight time would be limited to 8 hours and the rest period would be at least 8 consecutive hours during any 24 consecutive hours. No emergency evacuation assignment would be allowed to exceed 72 consecutive hours at the hospital. In order to assure that a helicopter pilot is adequately rested, there would have to be an approved place of rest at, or in close proximity to, the hospital at which the helicopter is based. In addition, an extended rest period would be required at the completion of an assignment. These air ambulance operations are of undoubted social benefit and proven safety. The FAA has been issuing exemptions for these operations for several years and is satisfied that they are safe. This proposal codifies the terms of the typical exemption for emergency evacuations.

Economic Evaluation

The proposals in this NPRM are expected to generate no net cost, while maintaining or increasing the level of safety. Although there are a number of changes in the regulation, any potentially costly changes would be balanced by benefits. Major changes are discussed below.

Part 121

The basic changes in Part 121 would be the inclusion of a minimum rest period for periods when flight time is less than 8 hours in any 24 consecutive hours, and changes in the required rest periods when flight time is 8 hours or more in any 24 consecutive hours. The first change is not expected to involve significant cost, because the required rest period is only 9 hours and it can be reduced to 7½ hours if a longer rest is provided at the next scheduled rest period. The second change stipulates that a rest period of 10 hours must be given if the flight time exceeds 8 hours in any 24 consecutive hours, and 11 hours if the flight time exceeds 9 hours in any 24 consecutive hours. These periods may be reduced if longer rests are given at the next scheduled rest periods. The present regulation requires that if a flight crewmember exceeds 8 hours of flight in 24 consecutive hours, an intervening rest period must be given of twice the flight time before the rest period; also, at the end of the crewmember's "series of flights," there must be a 16-hour rest period granted. While the proposed rule is substantively different from the present rule, the FAA believes it will be beneficial to operators, allowing somewhat more flexibility than the present rule.

Part 135

There are a number of changes from the present rule. In particular, different rules would be provided for scheduled versus non-scheduled operations. The proposed rule for Part 135 is similar to that for Part 121. However, the weekly, monthly, and annual maximum flight hours for all Part 135 operators are somewhat higher than the Part 121 limits.

The proposed Part 135 non-scheduled regulations are similar to present regulations except that certain penalties in the present rule are moderated, while quarterly and annual flight time limits are added.

Both scheduled and non-scheduled proposals are based on industry recommendations to the committee. As such, they were presented as acceptable from a cost standpoint, and thus were only generally reviewed from a benefit/cost standpoint. The costs are expected to be minimal. For example, certain monthly, quarterly, and annual hours will have to be checked by operators. This is a minimal cost, since basic payroll type records already provide simple building blocks for developing such data.

A number of elements incorporated in the proposal would eliminate potentially costly situations. For example, non-scheduled operations have no requirement for 1 day off in 7, but are required to give 13 days off per calendar quarter. This provides the flexibility needed by non-scheduled operations. From comments to previous NPRM's, the FAA knows that there would be a significant cost if the rule required 1 day off in 7.

As outlined in the discussion of the proposals, other rule elements are either non-costly, relaxatory, or they are codifications of present exemptions. As such they are not expected to have a net cost to any segment of the industry. Also, while there are benefits to some of the changes, these are not readily quantifiable. Only the air carriers can accurately determine, by comparing crew scheduling options under present rules to the proposals, whether costs or benefits are associated with the proposals.

Under the terms of the Regulatory Flexibility Act of 1980, Federal agencies must review regulatory proposals with particular concern about the impact rules might have on small entities. The proposals will not have significant economic impact on a substantial number of small entities because the only costs implied (those for keeping track of total flight hours on a quarterly and annual basis) are minimal and are balanced by benefits of new flexibilities in the rules.

List of Subjects

14 CFR Part 121

Aviation safety, Safety, Air carriers, Air traffic control, Air transportation, Aircraft, Aircraft pilots, Airmen, Airplanes, Airports, Airspace, Airworthiness directives and standards, Beverages, Cargo, Chemicals, Children, Narcotics, Flammable materials, Handicapped, Hazardous materials, Hours of work, Infants, Liquor, Mail, Drugs, Pilots, Smoking, Transportation, Common carriers.

14 CFR Part 135

Air carriers, Airplanes, Airspace, Aviation safety, Air traffic control, Air transportation, Air taxi, Airworthiness, Airmen, Aircraft, Alcohol, Airports, Baggage, Beverages, Cargo, Chemicals, Drugs, Handicapped, Hazardous materials, Helicopters, Hours of work, Mail, Narcotics, Pilots, Safety, Smoking, Transportation, Weapons.

Proposed Rule

In consideration of the foregoing, the Federal Aviation Administration proposes to amend Parts 121 and 135 of the Federal Aviation Regulations (14 CFR Parts 121 and 135) as follows:

PART 121—CERTIFICATION AND OPERATIONS: DOMESTIC, FLAG AND SUPPLEMENTAL AIR CARRIERS AND COMMERCIAL OPERATORS OF LARGE AIRCRAFT

1. By revising the table of contents of Subpart Q of Part 121 to read as follows:

Subpart Q—Flight Time Limitations: Domestic Air Carriers

2. By revising Subpart Q of Part 121 to read as follows:

Subpart Q—Flight Time Limitations: Domestic Air Carriers

§ 121.470 Applicability.

This subpart prescribes flight time limitations for domestic air carriers.

§ 121.471 Flight time limitations: All flight crewmembers.

(a) Except as provided in paragraph (h) of this section, no domestic air carrier may schedule any flight crewmember and no flight crewmember may accept an assignment for flight time in scheduled air transportation or in other commercial flying if that crewmember's total flight time in all commercial flying will exceed—

(1) 1,000 hours in any calendar year;

(2) 100 hours in any calendar month;

(3) 30 hours in any 7 consecutive days;

(4) 9 hours between rest periods.

(b) Except as provided in paragraph (c) of this section, no domestic air carrier may schedule a flight crewmember and no flight crewmember may accept an assignment for flight time during the 24 consecutive hours preceding the scheduled completion of any flight segment without a scheduled rest period during that 24 hours as follows:

(1) 9 consecutive hours of rest for less than 8 hours of flight time.

(2) 10 consecutive hours of rest for 8 or more but less than 9 of flight time.

(3) 11 consecutive hours of rest for 9 or more hours of flight time.

(c) An air carrier may schedule a flight crewmember for less than the rest required in paragraph (b) of this section or may reduce a scheduled rest under the following conditions:

(1) A rest required under paragraph (b)(1) of this section may be scheduled for or reduced to a minimum of 7½ hours if the flight crewmember is given at his next scheduled rest period 10 hours of rest before being assigned to any further flight time with the air carrier.

(2) A rest required under paragraph (b)(2) of this section may be scheduled for or reduced to a minimum of 8 hours if the flight crewmember is given at his next scheduled rest period 11 hours of rest before being assigned to any further flight time with the air carrier.

(3) A rest required under paragraph (b)(3) of this section may be scheduled for or reduced to a minimum of 9 hours if the flight crewmember is given at his next scheduled rest period 12 hours of rest before being assigned to any further flight time with the air carrier.

No air carrier may assign, nor may any flight crewmember perform any flight time with the air carrier unless the flight crewmember has had at least the minimum rest required under this paragraph.

(d) Each domestic air carrier shall relieve each flight crewmember engaged in scheduled air transportation from all further duty for at least 24 consecutive hours during any 7 consecutive days.

(e) No domestic air carrier may assign any flight crewmember and no flight crewmember may accept assignment to any duty with the air carrier during any required rest period.

(f) Time spent in transportation, not local in character, that an air carrier requires of a flight crewmember and provides to transport the crewmember to an airport at which he is to serve on a flight as a crewmember, or from an airport at which he was relieved from duty to return to his home station, is not considered part of a rest period.

(g) A flight crewmember is not considered to be scheduled for duty in excess of flight time limitations if the flights to which he is assigned are scheduled and normally terminate within the limitations, but due to circumstances beyond the control of the air carrier (such as adverse weather conditions) are not at the time of departure expected to reach their destination within the scheduled time.

(h) For operations of propeller driven multiengine airplanes having a passenger seating configuration of 31–60 seats and a payload capacity of 18,000 pounds or less, no air carrier may schedule any flight crewmember for flight time in scheduled air transportation or in other commercial flying if that crewmember's total flight time in all commercial flying will exceed—

(1) 1,200 hours in any calendar year.

(2) 120 hours in any calendar month.

(3) 32 hours in any 7 consecutive days.

(4) 9 hours between rest periods.

PART 135—AIR TAXI OPERATORS AND COMMERCIAL OPERATORS

3. By revising the table of contents of Subpart F of Part 135 to read as follows:

Subpart F—Flight Crewmember Flight Time Limitations

4. By revising Subpart F of Part 135 to read as follows:

Subpart F—Flight Crewmember Flight Time Limitations

§ 135.26 Applicability.

Section 135.263 through 135.271 prescribe flight time limitations and rest requirements for operations conducted under this part as follows:

(a) Section 135.263 applies to all operations under this subpart.

(b) Section 135.265 applies to scheduled operations except scheduled operations conducted solely within the state of Alaska. "Scheduled operations" means passenger-carrying operations that are conducted in accordance with a published schedule of at least five round trips per week on at least one route between two or more points which includes dates or times (or both) that is openly advertised or otherwise made readily available to the general public.

(c) Section 135.267 and 135.269 apply to air taxi operations, commercial operator operations, and operations conducted solely within the state of Alaska.

(d) Section 135.271 contains special daily flight time limits for operations conducted under the helicopter emergency medical evacuation service (HEMES).

§ 135.263 Flight time limitations: All certificate holders.

(a) A certificate holder may assign a flight crewmember and a flight crewmember may accept an assignment for flight time only when the applicable requirements of §§ 135.263 through 135.271 are met.

(b) No certificate holder may assign any flight crewmember to any duty with the air carrier during any required rest period.

(c) Time spent in transportation, not local in character, that a certificate holder requires of a flight crewmember and provides to transport the crewmember to an airport at which he is to serve on a flight as a crewmember, or from an airport at which he was relieved from duty to return to his home station, is not considered part of a rest period.

(d) A flight crewmember is not considered to be scheduled for duty in excess of flight time limitations if the flights to which he is assigned are scheduled to and normally terminate within the limitations, but due to circumstances beyond the control of the air carrier or flight crewmember (such as adverse weather conditions), are not at the time of departure expected to reach their destination within the scheduled time.

(e) When a flight crewmember has exceeded the daily flight time limitations in § 135.265 through 135.271, because of circumstances beyond the control of the certificate holder or flight crewmember (such as adverse weather conditions), that flight crewmember must have a rest period before the next duty period of at least—

(1) 11 consecutive hours of rest if the flight time limitation is exceeded by not more than 30 minutes;

(2) 12 consecutive hours of rest if the flight time limitation is exceeded by more than 30 minutes, but not more than 60 minutes; and

(3) 16 consecutive hours of rest if the flight time limitation is exceeded by more than 60 minutes.

The rest requirements of this paragraph supersede shorter rest requirements of this subpart.

(f) Within 2 years after the issuance of this rule, the Director of Flight Operations may issue operations specifications authorizing a deviation from any specific requirement of §§ 135.267 and 135.269 if he finds that the deviation provides a substantially equivalent standard of safety.

§ 135.265 Flight time limitations: Scheduled operations.

(a) No air carrier may schedule any flight crewmember for flight time in scheduled operations or in other commercial flying if that crewmember's total flight time in all commercial flying will exceed—

(1) 1,200 hours in any calendar year.

(2) 120 hours in any calendar month.

(3) 32 hours in any 7 consecutive days.

(4) 8 hours during any 24 consecutive hours for a flight crew consisting of one pilot.

(5) 9 hours between rest periods for a flight crew consisting of two pilots.

(b) Except as provided in paragraph (c) of this section, no air carrier may schedule a flight crewmember for flight time during the 24 consecutive hours preceding the scheduled completion of any flight segment without a scheduled rest period during that 24 hours as follows:

(1) 9 consecutive hours of rest for less than 8 hours of flight time.

(2) 10 consecutive hours of rest for 8 or more but less than 9 hours of flight time.

(3) 11 consecutive hours of rest for 9 or more hours of flight time.

(c) An air carrier may schedule a flight crewmember for less than the rest required in paragraph (b) of this section or may reduce a scheduled rest under the following conditions:

(1) A rest required under paragraph (b)(1) of this section may be scheduled for or reduced to a minimum of 7½ hours if the flight crewmember is given at his next scheduled rest period 10 hours of rest before being assigned to any further flight time with the air carrier.

(2) A rest required under paragraph (b)(2) of this section may be scheduled for or reduced to a minimum of 8 hours if the flight crewmember is given at his next scheduled rest period 11 hours of rest before being assigned to any further flight time with the air carrier.

(3) A rest required under paragraph (b)(3) of this section may be scheduled for or reduced to a minimum of 9 hours if the flight crewmember is given at his next scheduled rest period 12 hours of rest before being assigned to any further flight time with the air carrier.

(d) Each air carrier shall relieve each flight crewmember engaged in scheduled air transportation from all further duty for at least 24 consecutive hours during any 7 consecutive days.

§ 135.267 Flight time limitations: Non-scheduled one- and two-pilot crews.

(a) No certificate holder may assign any flight crewmember, and no flight crewmember may accept an assignment, for duty during flight time if that crewmember's total flight time in all commercial flying will exceed—

(1) 500 hours in any calendar quarter.

(2) 800 hours in any two consecutive calendar quarters.

(3) 1,400 hours in any calendar year.

(b) Except as provided in paragraph (c) of this section, during any 24 consecutive hours the total flight time of the assigned flight when added to any other commercial flying by that flight crewmember may not exceed—

(1) 8 hours for a flight crew consisting of one pilot; or

(2) 10 hours for a flight crew consisting of two pilots qualified under this Part.

(c) A flight crewmember's flight time may exceed the flight time limits of paragraph (b) of this section if the assigned flight time occurs during a regularly assigned duty period of no more than 14 hours and—

(1) If this duty period is immediately preceded by 10 or more consecutive hours of rest;

(2) If flight time is assigned during this period, that total flight time when added to any other commercial flying by the flight crewmember may not exceed—

(i) 8 hours for a flight crew consisting of one pilot; or

(ii) 10 hours for a flight crew consisting of two pilots; and

(3) If the combined duty and rest periods equal 24 hours.

(d) Each assignment under paragraph (b) of this section must provide for at least 10 consecutive hours of rest during the 24-hour period that precedes the planned completion time of the assignment.

(e) Each assignment under paragraph (c) of this section must be immediately preceded by and followed by 10 consecutive hours of rest.

(f) The certificate holder must provide each flight crewmember at least 13 rest periods of at least 24 consecutive hours each in each calendar quarter.

§ 135.269 Flight time limitations: Non-scheduled three- and four-pilot crews.

(a) No certificate holder may assign any flight crewmember for duty during flight time if the crewmember's total flight time in all commercial flying will exceed—

(1) 500 hours in any calendar quarter.

(2) 800 hours in any two consecutive calendar quarters.

(3) 1,400 hours in any calendar year.

(b) A certificate holder must provide each flight crewmember at least 13 rest periods of at least 24 consecutive hours each in each calendar quarter.

(c) No certificate holder may assign any pilot to a crew of three or four pilots, unless that assignment provides—

(1) At least 10 consecutive hours of rest immediately preceding the assignment;

(2) No more than 8 hours of flight time in any 24 consecutive hours;

(3) No more than 18 duty hours for a three-pilot crew or 20 duty hours for a four-pilot crew in any 24 consecutive hours;

(4) No more than 12 hours aloft for a three-pilot crew or 16 hours aloft for a four-pilot crew during the maximum duty hours specified in paragraph (c)(3) of this section;

(5) Approved sleeping facilities on the aircraft for the relief pilot;

(6) Upon completion of the assignment, a rest period of at least 12 hours;

(7) For a three-pilot crew, a crew which consists of at least the following:

(i) A pilot in command (PIC) who meets the applicable flight crewmember requirements of Subpart E of Part 135;

(ii) A PIC who meets the applicable flight crewmember requirements of Subpart E of Part 135, except those prescribed in § 135.244 and 135.247; and

(iii) A second in command (SIC) who meets the SIC qualifications of § 135.245

(8) For a four-pilot crew, at least three pilots who meet the conditions of paragraph (c)(7) of this section, plus a fourth pilot who meets the SIC qualifications of § 135.245.

§ 135.271 Helicopter hospital emergency medical evacuation service (HEMES).

(a) A certificate holder operating under this section must also comply with § 135.267 (a) and (f).

(b) No certificate holder may assign a helicopter pilot for hospital emergency medical evacuation service helicopter operations unless that assignment provides for at least 10 consecutive hours of rest immediately preceding reporting to the hospital for availability for duty during flight time.

(c) No pilot may fly for more than 8 hours during any 24-consecutive hour period of a HEMES assignment.

(d) Each pilot must be given at least 8 consecutive hours of rest during any 24 consecutive hour period of a HEMES assignment.

(e) A HEMES assignment may not exceed 72 consecutive hours at the hospital.

(f) An approved place of rest must be provided at, or in close proximity to, the hospital at which the HEMES assignment is being performed.

(g) No certificate holder may assign any other duties during a HEMES assignment.

(h) Each pilot must be given a rest period upon completion of the HEMES assignment and prior to being assigned any further duty with the certificate holder of—

(1) 12 consecutive hours for an assignment of at least 24 hours but less than 48 hours.

(2) 16 consecutive hours for an assignment of more than 48 hours.

(Sec. 313, 314, and 601 through 610, Federal Aviation Act of 1958 (49 U.S.C. 1354, 1355, and 1421 through 1430); 49 U.S.C. 106(g) (revised, Pub. L. 97–449, January 12, 1983); and 14 CFR 11.45)

Note.—This notice proposes regulatory changes that are based on the discussions and recommendations of a regulatory negotiation advisory committee. Since this committee included representatives from the air transportation industry, the FAA believes that these regulatory proposals are not costly. Therefore, the FAA has determined that this notice involves a rulemaking action which: (1) Is not a "major rule" under Executive Order 12291, and (2) is not a "significant rule" under Department of Transportation Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). In addition, it is certified that the proposals, if promulgated, will not have a significant economic impact on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. A copy of the draft evaluation prepared for this action is contained in the regulatory docket. A copy of it may be obtained by contacting the person identified under the caption "**FOR FURTHER INFORMATION CONTACT.**"

Issued in Washington, D.C., on February 23, 1984.

Kenneth S. Hunt,

Director of Flight Operations.

[FR Doc. 84–8233 Filed 3–27–84; 8:45 am]

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federal register

Wednesday
March 28, 1984

Part V

Department of Energy

Office of Conservation and Renewable Energy

10 CFR Part 430

Energy Conservation Program for Consumer Products; Test Procedures for Furnaces, Vented Home Heating Equipment and Unvented Home Heating Equipment; Final Rule

DEPARTMENT OF ENERGY

Office of Conservation and Renewable Energy

10 CFR Part 430

[Docket No. CAS-RM-79-104]

Energy Conservation Program for Consumer Products; Test Procedures for Furnaces, Vented Home Heating Equipment, and Unvented Home Heating Equipment

AGENCY: Office of Conservation and Renewable Energy, DOE.

ACTION: Final rule.

SUMMARY: The Department of Energy (DOE) hereby prescribes amendments to its test procedures for furnaces, vented home heating equipment, and unvented home heating equipment. These test procedures are one part of the energy conservation program for consumer products established pursuant to the Energy Policy and Conservation Act as amended by the National Energy Conservation Policy Act. Among other program elements, the legislation requires that standard methods of testing be prescribed for 13 covered products.

DOE is referencing, the American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 103–82 into the furnace test procedure. Other amendments prescribed today for furnaces include test procedures for modulating furnaces and boilers, condensing furnaces and boilers, and thermal stack dampers, and other technical revisions. Amendments prescribed today for vented home heating equipment include test procedures for vented heaters with thermal stack dampers and/or manual controls and a simplified test procedure which covers modulating vented heaters. Amendments prescribed today for unvented home heating equipment include test procedures for unvented heaters that use natural gas, propane, or kerosene. DOE is also including an estimated cost per million Btu output as a measure of energy use for vented and unvented heaters.

EFFECTIVE DATE: (30 days from publication)

FOR FURTHER INFORMATION CONTACT:

Michael J. McCabe, U.S. Department of Energy, Office of Conservation and Renewable Energy, Forrestal Building, Mail Station CE-113.1, 1000 Independence Avenue, SW., Washington, D.C. 20585 (202) 252-9127

Eugene Margolis, Esq., U.S. Department of Energy, Office of General Counsel, Forrestal Building, Mail Station GC-33, 1000 Independence Avenue, SW., Washington, D.C. 20585 (202) 252-9513.

SUPPLEMENTARY INFORMATION:

I. BACKGROUND

On October 1, 1977, the Department of Energy (DOE) assumed the authority of the Federal Energy Administration (FEA) for the energy conservation program for consumer products, under Section 301 of the Department of Energy Organization Act (DOE Act) (Pub. L. 95-91). The energy conservation program for consumer products was established by FEA pursuant to Title III, Part B of the Energy Policy and Conservation Act (EPCA) (Pub. L. 94-163). Subsequently, EPCA was amended by the National Energy Conservation Policy Act (NECPA) (Pub. L. 95-619). References in this notice to the Act, or to sections of the Act, refer to EPCA as amended by NECPA. Among other program elements, Section 323 of the Act requires that standard methods of testing be prescribed for covered products. Test procedures appear at 10 CFR 430, Subpart B.

II. DISCUSSION OF COMMENTS

In general, the received comments were supportive of the proposed amendments; consequently for most of the issues, today's notice prescribes the amendments as proposed. For each issue, the following discussion sections repeat the background information that was presented in the proposal followed by a characterization of the comments received and a statement delineating the disposition of the issue with regards to today's final rule. Also, some additional issues were brought up during the comment period. Where appropriate, those issues are also discussed here today.

A. Furnace Test Procedure

Test procedures for furnaces were prescribed by DOE by notice issued May 2, 1978. 43 FR 20155 (May 10, 1978). DOE amended the furnace test procedures by notice issued August 4, 1980. 45 FR 53720 (August 12, 1980). The amendment included provisions for pulse combustion and condensing furnaces and technical revisions. Subsequently, DOE has become aware of additional areas of concern through cooperative efforts with the furnace industry and by the test procedure waiver process. Specifically, manufacturers of condensing furnaces and boilers felt an improved method of testing was warranted to determine the amount of beneficial condensation produced in their designs; manufacturers of boilers felt the test procedure needed further clarification in the area of advanced controls (modulating controls and pump delay controls); utilities and research groups identified the need for improving the test procedure with regard to stack dampers and draft hood designs; and the furnace industry expressed the need for the test procedure to specifically outline the method of test for units installed in "isolated combustion systems." On the basis of the information submitted under the waiver process, research done by the National Bureau of Standards (NBS), and other available information, DOE proposed to amend the furnace test procedure to address all these concerns. 48 FR 28014 (June 17, 1983) hereafter referred to as the June 17 proposal. Subsequently, a public hearing was held on June 29, 1983 and comments were received regarding the proposed rule.

1. ANSI/ASHRAE Standard 103–82

When the test procedures were initially developed in 1976 and 1977, existing commercial standards were referenced wherever possible. The final test procedures prescribed by DOE reference sections from many commercial standards developed by various consensus standard organizations, such as ASHRAE, Air-Conditioning and Refrigeration Institute, American National Standards Institute, Association of Home Appliance Manufacturers, and Underwriters Laboratory. However, at the time when DOE was developing test procedures for residential furnaces and boilers, no commercial standard existed from ASHRAE, or any other organization, that could meet the needs of the Act. Specifically, no commercial standard was available for referencing by DOE that could be used to determine the annual energy consumption of a furnace as outlined in EPCA. Thus, DOE and NBS set out to develop a test procedure methodology that would satisfy the legislative requirements. This effort included referencing portions of certain commercial standards for the purposes of including test set up and instrumentation provisions that were already established in the test methods used by the furnace industry at that time.

As mentioned above, final test procedures for residential furnaces were prescribed by DOE, pursuant to the Act, on May 10, 1978. In 1980, the test procedures were amended to include new furnace designs and to make some technical revisions. Following the establishment of the test procedure amendments ASHRAE initiated the development of a standard method of measurement and test for residential furnaces and boilers that could be referenced by DOE in its test procedures. ASHRAE established a Standards Project Committee, with representation from Industry, Government, and Research groups, for the purpose of developing a consensus standard for testing furnaces and boilers. The resulting commercial standard is now available entitled "Methods of Testing for Heating Seasonal Efficiency of Central Furnaces and Boilers ASHRAE 103-82." DOE believes the referencing of the ASHRAE Standard will not result in a difference in efficiency ratings since the Project Committee has essentially adopted the existing DOE test methods.

DOE is required by Section 32 of the FEA Act to alert the public to the use and background of commercial standards in a proposed rulemaking and, through the comment and hearing process, allow interested persons to make known their views regarding the appropriateness of the use of particular commercial standards in any proposed rulemaking.

In addition to identifying the organization which promulgated the standard to be used, Section 32 requires that the Secretary make a judgmental statement concerning the organization process of promulgating any of its standards (i.e. are all interested persons given adequate notice, is there effective representation of all interested persons in the membership, are all proceedings of the organization made available to the public, and can any interested persons obtain reconsideration and review of any action taken by the organization).

In the June 17, 1983 proposal it was the judgment of DOE that ASHRAE standards are not developed in a manner which provided for public participation, comment and review. ASHRAE (ASHRAE, No. 4, at 1),[1] American National Standards Institute (ANSI) (ANSI, No. 5 at 1), and GAMA (GAMA No. 12, at 1), all took exception to this statement and offered that ASHRAE and ANSI[2] procedures do clearly provide for public participation, comment, and review. DOE has reviewed the procedures of these organizations and agrees that, if complied with, these procedures will provide for public participation, comment, and review.

In addition, as required by Section 32(c) of FEA Act, DOE has consulted with the Attorney General and the Chairman of the Federal Trade Commission (FTC) regarding referencing ASHRAE Standard 103-82 into furnace test procedures. (Letters from DOE to the Attorney General and FTC dated July 26, 1983.)

All comments received concerning the use of ASHRAE Standard 103-82 expressed approval. In addition, neither the Attorney General nor the Chairman of FTC recommends against such referencing or use. (Letter from Attorney General dated September 14, 1983, letter from FTC dated September 12, 1983.) Therefore, DOE is referencing in today's final rule the ASHRAE Standard 103-82.

Since the standard has received approval from the American National Standards Institute (ANSI), the standard has been designated as the ANSI/ ASHRAE Standard 103-82. Today's final rule reflects this change.

2. Modulating Furnaces and Boilers

The furnace and vented heater test procedures were developed to reflect the fact that furnaces, boilers and vented heaters operate either at the maximum firing rate or are off. This is called single step control. For heating equipment that is designed to operate at various firing rates, both the vented heater and furnace test procedures require that the testing is to be based only on the maximum firing rate. It was thought that the results of such testing were reasonably accurate and further complication of an already complicated test procedure was not warranted. However, since that time, two vented heater and three furnace manufacturers have petitioned the Department's Office of Hearings and Appeals (OHA) for an Exception from the existing test procedure on the grounds that such procedures are not appropriate for their units which have modulating controls.[3] These petitioners felt that modified test procedures are necessary to account for operation with fuel modulation. OHA agreed with the petitioners and has granted an exception in each case. However, no testing provisions were specified in these grants regarding modulating controls. A revised procedure which accommodates two types of fuel modulating controls was developed by NBS and the June 17 proposal proposed this revised procedure.

The two types of modulating controls are:

1. "Step-modulating thermostat control" means a control that reduces burner fuel input rate if the heating load is light, or gradually increases or steps-up the heat input to meet any higher heating load that cannot be met with the low firing rate.

2. "Two stage thermostat control" means a control that either cycles a burner at the reduced heat input rate and off, or cycles a burner at the maximum heat input rate and off.

A. *Proposed Amendment*—The June 17 proposal included methods for measuring the Annual Fuel Utilization Efficiency (AFUE) for modulating furnaces and boilers by devising two new measures, weighted average steady state efficiency and weighted average part load efficiency. The methods are more fully described in the technical support document, *A Test Method and Calculation Procedure for Determining Annual Efficiency for Vented Household Heaters and Furnaces Equipped with Modulating-Type Controls*, NBSIR 82-2497, May 1982.

The June 17 proposal outlined calculation methods for two types of variable firing rate controls, i.e., step-modulating and two stage. All comments received expressed approval of these methods. However, Teledyne Laars and Raypak, Inc. requested clarification in the final rule on which calculation method is to be used when testing their particular design of two stage control. *See* Teledyne Laars and Raypak, Inc. No. 9, at 4. Specifically, the June 17 proposal assumes that two stage controls operate either from off to minimum and then to off, or from off to maximum and then to off. Their design of modulating controls differ in that they can operate from off to minimum to maximum and back to minimum (more than once) without ever going through an off cycle. NBS has determined that the proposed test method for step modulating controls is appropriate for this design of controls. Thus, the final rule is the same as the proposed rule with the addition of clarifying language

[1] Comments on the rulemaking were given docket numbers. Citations to comments provide the docket numbers, unless the comment was submitted as part of an oral presentation, in which case the citation is to the date and the numerical order of the presentation.

[2] ASHRAE Standards 103-82 received approval as an ANSI Standard on June 21, 1983.

[3] Dearborn Stove Company, Case No. BEE-0883, *Federal Energy Guidelines*, 6 DOE 81,060.

Atlanta Stove Works, Case No. BEE-0983, *Federal Energy Guidelines*, 6 DOE 81,109.

Raypak, Inc., Case No. HXE-0012, *Federal Energy Guidelines*, 9 DOE 81,038.

Teledyne Laars, Case No. HXE-0013, *Federal Energy Guidelines*, 9 DOE 81,038

A. O. Smith Corporation, Case No. HXE-0018, *Federal Energy Guidelines*, 81,042 involving user-evaluation of the control. Specifically, this control design is defined as a step modulating control in the definitions.

Also, in early comments, Raypak, Inc. expressed concerns about the appropriateness of the proposed provisions for modulating boilers in general. *See* Raypak, Inc., No. 1, at 1. However, the final comments from Raypak, Inc. endorsed these provisions as proposed. *See* Raypak, Inc., No. 6.

B. *Oversize Factor of Furnaces and Boilers*—In the existing furnace test procedure, the value of efficiency used to determine the estimated annual operating cost is prescribed to be constant for all design heating loads regardless of the extent that the capacity of the installed furnace exceeds the design heating load, i.e. the extent of oversizing. The existing furnace test procedures are only applicable to units with single-stage controls. Consequently, where the FTC labeling rule for furnaces and boilers requires annual operating costs for various design heating load to be determined, these costs are based on a single value of efficiency. NBS has found that oversizing has little effect on the efficiency of furnaces and boilers equipped with single stage controls.

However, the efficiency of modulating furnaces and boilers depend on the fraction of the heating load that occurs during the various firing rates. In turn, the fraction is dependent on the extent of oversizing. Consequently, for modulating units, DOE believes the test procedure should reflect the change in efficiency due to the differences in oversizing. This would allow the FTC labeling program to present the consumer with a valid evaluation of modulating furnaces and boilers.[4] Specifically, the labeled operating costs under each design heating load that appears on the FTC EnergyGuide Fact Sheet, will be based on the appropriate value of efficiency for the degree of oversizing that each design heating load represents.

Consequently, the June 17 proposal provided for a separate efficiency and annual cost calculation to be made for each oversizing factor, corresponding to each typical design heating load listed in Table 1 of the test procedure.

Teledyne Laars and Raypak, Inc. objected to the requirement to calculate the efficiency for each degree of oversizing. *See* Teledyne Laars and Raypak, Inc., No. 9, at 2. It is their belief that disclosure of these different efficiencies would be of little or no use to the consumer since most consumers do not understand what oversizing means and are not likely to use FTC EnergyGuide fact sheets in any event. DOE disagrees with this contention and fails to see any merit to reducing the accuracy of a test procedure on such a basis. The procedure to determine the different efficiencies is simply an arithmetic exercise with no additional testing required. Since the energy savings potential of modulating controls depends on the extent of oversizing, DOE feels it is justified to require these additional calculations.

These same commenters stated that the proposed test procedures do not provide for the use of zone controls for boilers, and therefore will not recognize the benefits of such widely used systems. *See* Teledyne Laars and Raypak, Inc. No. 9, at 3. DOE realizes this shortcoming but is reluctant to expand the test procedures to allow different ratings for installations with and without zone controls. As with other installation variables (i.g. chimney height) DOE has sought to be as representative as possible. Since most residential boiler installations are without zone controls, DOE believes it appropriate to have the efficiency ratings based on this single condition. Further, the expansion necessary to accommodate zone controls would be significantly more than that already objected to above (i.e. an efficiency for each degree of oversizing). This expansion would apply not only to modulating boilers but to all boilers. Therefore, DOE is not considering expanding the test procedures to accommodate zone controls at this time.

Hydrotherm Inc., a manufacturer of boilers which are equipped with modulating controls, has been granted a test procedure waiver to use the modulating control test provisions outlined in the June 17 proposal. 48 FR 55020 (December 8, 1983). The effective date of the final rule constitutes the official expiration of the test procedure waiver by Hydrotherm Inc. (F–009). Today's provisions reflect exactly the provisions granted in the Hydrotherm waiver (F–009).

Also, since the above mentioned test procedure exceptions, HXE–0012, HXE–0013, and HXE–0018, (delineated in footnote 3) were partially granted on the basis that no modulating control provisions were included in the existing test procedures, the effective date of this rule constitutes the expiration of those exceptions with regard to modulating controls. Further, those exceptions are superceded on the effective date of today's rule since all the grounds for these exceptions are now addressed. (*See* Section II a 9 "Pump Delay Boiler Controls" below).

3. Condensing Furnaces and Boilers

A. *Direct Condensate Method*—DOE has granted waivers to Hydrotherm, Inc. (Hydrotherm), Lennox Industries, Inc. (Lennox), Arkla Industries, Inc. (Arkla), Amana Refrigeration, Inc. (Amana), Duo/Matic Olsen, Inc. (Duo/Matic) and Heil Quaker Corporation (Heil) from the existing test procedures for furnaces and boilers because the prescribed test procedures do not adequately consider the improvement in energy efficiency attributable to the condensing and the removing of water in the flue products. 46 FR 34621 (July 2, 1981). 47 FR 32471 (July 27, 1982). 47 FR 57987 (December 29, 1982). 48 FR 28531 (June 22, 1983). 48 FR 41213 (September 14, 1983). 48 FR 41215 (September 14, 1983), respectively.

The test procedure waivers specified that the manufacturers use the test method outlined in Appendix C of the NBS report, *Recommended Testing and Calculation Procedures for Estimating the Seasonal Performance of Residential Condensing Furnaces and Boilers*, NBSIR 80–2110, April 1981. The June 17 proposal was identical to the requirements of the waivers except it proposed a six cycle test in lieu of three cycles. Hydronics Institute (HI), Carrier Corp., GAMA and Trane indicated that the six cycle test was burdensome especially for those designs that have repeatable condensate collection rates. *See* HI, No. 8, at 4, Carrier, No. 10, at 4; GAMA, No. 12, at 3; and Trane, No. 14, at 2. Also, the one hour period for the steady-state collection test was thought to be excessive by these commenters. NBS analyzed these issues and agrees with the recommended reduction in the number of required cycles for units with repeatable condensate collection rates and the reduction in steady-state testing time.

Accordingly, today's final rule prescribes a ½ hour steady-state test and a three cycle test for those furnaces and boilers with repeatable condensate collection rates. A furnace or boiler is considered to have a repeatable condensate collection rate if it can demonstrate a standard deviation less than 20 percent of the mean per cycle condensate collected after three cycles. For those furnaces and boilers which do not demonstrate a repeatable condensate collection rate in these first three cylces, and additional three cycles are required irrespective of variability.

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[4] FTC labeling program for furnaces consists of a requirement to produce "EnergyGuide Fact Sheets" that report estimates of annual operating costs for several different design heating loads (degrees of oversizing).

The effective date of this final rule constitutes the official expiration of the following waivers: Hydrotherm (F–002), Lennox (F–004), Arkla (F–005), Amana (F–006), Duo-Matic/Olsen (F–008) and Heil (F–010). Today's rule differs from what was granted in these six waivers in that one hour steady-state test is changed to a 30 minute test and the cyclic test may be 3 cycles in length instead of 6 cycles in length.

4. Energy Efficiency Descriptor

Although not directly related to any of the issues raised in the June 17 proposal, many commenters discussed the need for an energy efficiency descriptor (energy efficiency rating) to account for the electrical energy used by a fossil fueled furnace in addition to the fossil fuel used. The descriptor AFUE only accounts for the fossil fuel efficiency. *See* TRD, No. 7, at 1; Carrier, No. 10, at 1; and GAMA, No. 12, at 8. The proposed provisions for modulating controls drew these comments since in most modulating designs improved fuel efficiency (AFUE) is obtained at the expense of additional electrical energy consumption, (e.g. increased blower run time). The existing regulation for determining annual operating costs does reflect this concept, since electrical and fuel costs are separately determined and then summed. The commenters felt that in addition to the annual operating cost provisions, an energy efficiency descriptor needs to be added that will fairly disclose to the consumer the relative performance of different designs of furnaces that use both fossil fuel and electricity. Commenters felt the situation is exacerbated by FTC's labeling program, where for furnaces the dominant disclosure is AFUE and annual operating costs are relegated to the bottom of the Fact Sheet in grid format. The consumer may make a purchasing decision solely on the AFUE and not consider the electrical cost as well. Carrier delineated an example of the misleading nature of comparisons based on AFUE by showing where a higher AFUE furnace had an actual higher annual operating cost. *See* Carrier Corp., No. 10, at 2. Obviously, this outcome was dependent on assumed relative costs of the fuel and electricity. Other relative costs assumptions could lead to the opposite outcome, i.e., higher AFUE, lower operating costs. The commenters suggested the adoption of a new efficiency descriptor that includes an *average* electricity to fuel cost ratio. Any rankings developed from this descriptor would be identical to that developed on the basis of annual operating costs using the same average electricity to fuel costs ratio. DOE sees some merit to an efficiency descriptor based on the average electricity to fuel cost ratio but feels there exists, already in DOE procedures, a superior method of rating a furnace's performance in all costs scenarios, not just average costs scenarios. The DOE procedures currently provide the method of calculation needed to explicitly detail the electrical energy cost and the fuel energy cost for any furnace.

Therefore, for the reasons discussed above today's final rule does not include a new energy efficiency descriptor. However, DOE will continue to examine this subject and may consider revisions at a later date.

5. Furnaces Without Draft Relief

The 1980 amendments clarified how to test gas furnaces equipped with reduced draft fans and no draft relief device. Specifically, a definition of "direct exhaust" was added and provisions to allow testing of direct exhaust systems were specified. In addition, the Carrier Corporation was granted a test procedure waiver for its induced draft gas furnace with a draft safeguard system. 46 FR 22799 (April 21, 1981). The waiver specified that the unit with a draft safeguard system is tested according to the same provisions specified in the 1980 amendments for "direct exhaust" systems.

The June 17 proposal would allow all manufacturers of similar designs to use the provisions granted to Carrier's draft safeguard system.

All commenters that addressed this issue agreed with the proposal. *See* HI, No. 8, at 4; Carrier, No. 10, at 3; ETL, No. 11, at 4; and Trane, No. 14, at 2. However, both GAMA and Hydronics Institute suggested that the term "draft safeguard system" is proprietary and should be eliminated. DOE agrees with the commenters, and today's final rule adopts the proposal except that the term "draft safeguard system" is eliminated.

The effective date of today's rule constitutes the official expiration of the Carrier waiver (F–001). Future rulemakings may consider the need to specify exactly how to determine this percent flue flow if it is found that today's provisions lead to difficulty in replicating the procedure.

6. Hot Water Boiler Specifications

Existing test procedures for non-condensing hot water boilers specify testing at a 120°F temperature rise and a 200°F outlet water temperature. These specifications generally are not difficult to achieve and thereby reduce the testing burden on manufacturers. However, some manufacturers of finned tube boilers were granted test procedure exceptions because their boilers cannot be tested safely at these conditions. (Exception requests by Teledyne Laars and Raypak, Office of Hearings and Appeals, Case Nos. DEE–3439 and DEE–3950). The August 1980 amendments to the furnace test procedures prescribed test procedures for finned tube boilers. Specifically, these amendments required boilers to be tested at at a 20°F to 40°F temperature rise and a 200°F outlet water temperature.

Since the 1980 amendments, Energy Kinetics (F–003), a manufacturer of boilers which are designed with low thermal mass, received a test procedure waiver to allow testing of its boilers under the provisions prescribed for finned tube boilers. 46 FR 58732 (December 3, 1981).

The June 17 notice proposed entirely new provisions, specifically all non-condensing hot water boilers are to be tested with a return inlet water temperature of at least 120°F and a water temperature rise of at least 20°F. DOE believed that all non-condensing hot water boilers, including finned tube boilers and low thermal mass boilers, generally operate at these conditions.

Teledyne Laars and Raypak agreed with these provisions but felt the exact test apparatus necessary to supply the 120°F water should be specified. *See* Teledyne Laars and Raypak, Inc., No. 9, at 4. DOE disagrees and would like to avoid further specification, because in this case no increase in test procedure accuracy is likely.

The effective date of today's final rule constitutes the official expiration of the water specifications provisions of the test procedure waiver granted to Energy Kinetics (F–003).

7. Thermal Stack Dampers

The June 17 proposal proposed a test method to directly measure the off-cycle losses for furnaces and boilers equipped with thermal stack dampers. These losses are the off-cycle infiltration loss ($L_{I,OFF}$) and the off-cycle sensible loss ($L_{S,OFF}$) which have been estimated in the past by the use of off-cycle draft factors for flue gas flow (D_F) and for stack gas flow (D_S). Currently, the off-cycle draft factors are assigned values in the existing furnace test procedure and these draft factors are adjusted if the unit is equipped with an electro-mechanical stack damper; this adjustment factor is the stack damper effectiveness factor D_O.

For furnaces and boilers with thermal stack dampers, the energy efficiency could not be accurately determined by using the value of D_O that was developed for electric-mechanical stack dampers. This is based on the fact that thermal stack dampers typically have changing off-period leakage rates, whereas electro-mechanical dampers typically have relatively constant off-period leakage rates. Also, the leakage rate is strongly dependent on temperature for thermal stack dampers whereas it is not dependent on temperature for electro-mechanical stack dampers.

The June 17 proposal allowed for the direct measurement of off-cycle losses by measuring the concentration of a tracer gas in the flue and in the stack during an appropriate off-cycle period and thereby eliminating any need for assigned draft factors. The method is based on the tracer gas method described in Appendix A of the NBS milestone report, *Recommendations to DOE on Modifications of Assigned Factors for Test Procedures for Vented Gas and Oil Fueled Heaters*, May 1980, and in Appendix D of ANSI/ASHRAE Standard 103–82. *See* NBS letter report, *An Analysis of Burner On and Off Periods and Their Effect on Part-Load Efficiency for Furnaces and Boilers Equipped with Modulating Controls*, January 1983.

Comments received regarding this issue approved of the proposal. *See* HI, No. 8, at 5 and Trane No. 14, at 2. However, GAMA's test procedure committee pointed out a number of questions that needed to be clarified before GAMA could fully support the provisions (e.g. should the thermal stack damper be in place for all parts of the test? should the thermal stack damper be insulated during testing? should the provision apply to furnaces with power burners?) *See* GAMA, No. 12, at 6. GAMA stated that the provision needed to be reproposed to allow comment on the complete procedures. DOE agrees and is reserving those provisions relating to thermal stack dampers until testing details and calculation procedures as required can be developed. These details and procedures are still being developed by the National Bureau of Standards. Thus, DOE will include these provisions in a separate notice.

8. Improvement in Stack (Flue) Damper Evaluation in the Test Procedures

Since the development of DOE furnace test procedures, it has been suspected by many interested parties that the actual energy efficiency improvement attributable to electro-mechanical stack (flue) dampers is less than that predicted in the test procedures. At this time, DOE is aware of analyses (both theoretical and field analyses) that support this conclusion. *See Proposed Framework for Furnace and Boiler Test Procedure Modifications*, a report to U.S. DOE Office of Buildings Energy Research and Development by Arthur D. Little, Inc., November 1982.

The current test procedure evaluates the effectiveness of a stack (flue) damper by comparing the area of the damper plate to the area of the stack. This simplified evaluation method ignores damper closing times. Thus, it is deficient in that it likely results in overstatements of efficiency. Also, the existing method discourages manufacturers from using quicker closing dampers.

The June 17 notice proposed that the direct measurement (tracer gas) method proposed for thermal stack dampers be allowed as an option for other than thermal stack flue dampers.

As with the provisions proposed for thermal stack dampers, all comments received expressed merit for the provisions. *See* HI, No. 8 at 5; GAMA, No. 12, at 6; and Trane, No. 14, at 2. However, since these provisions for all stack damper designs use essentially the same test method as was proposed for thermal stack dampers, the same questions as to the completeness of the proposed provisions were also raised. DOE agrees with these comments, therefore, DOE is reserving those provisions relating to the direct measurement method of testing all designs of stack dampers until testing details and calculation procedures as required can be developed.

9. Pump Delay Boiler Controls.

The June 17 proposal for pump delay boiler controls included a test method similar to that for time delay blower controls for furnaces, i.e. during testing the circulating pump is allowed to operate in accordance with its own control strategy. Maximum allowable time delays, a minimum return water temperature and a method for calculating the estimated annual operating cost to reflect the additional run time of the electrical circulating pump were proposed.

HI agreed with the proposal, especially for those control strategies that are time actuated. *See* HI, No. 8, at 6. However, HI felt clarification of the test method with regard to temperature actuated controls was required. It recommended a 15 minute fixed time delay be used for these controls. NBS reviewed these comments and also recommends the incorporation of this provision. Consequently, DOE has incorporated these provisions into today's final rule.

Three boiler manufacturers were granted test procedure exceptions which allowed testing under these provisions for pump delay. (Previously mentioned in footnote 3 were Raypak, Teledyne-Laars, and A. O. Smith). Since both pump delay and modulating controls are addressed, the effective date of today's final rule constitutes the official expiration of exceptions HXE–0012, HXE–0013, and HXE–0018.

DOE also received comments regarding the need to specify clearly the procedures for testing boilers designed for continous pump operations. *See* ETL, No. 11, at 1. This is done in today's rule by allowing such designs to have their laboratory testing conducted under continuous pump operation. In addition, the calculations are appropriately adjusted to reflect continuous operation.

10. Improved Method of Determining the S/F Factor for Furnaces and Boilers

A. Gas Furnaces and Boilers—The June 17 proposal included a method for calculating the S/F factor (average ratio of stack gas mass flow rate to flue gas mass flow rate at steady-state operation). The S/F factor is used to measure the on-cycle infiltration losses and the off-cycle infiltration losses in the furnace test procedure. The existing method is based on assigned values. The proposed method is based on the flue and stack measurements of CO_2 concentration, which already are required in the existing test procedures.

All comments received regarding these issues agreed with the proposal. *See* HI, No. 8, at 4; Carrier, No. 10, at 4; GAMA, No. 12, at 6; and Trane, No. 14, at 3. However, GAMA and the Hydronics Institute pointed out that though the flue and stack measurements of CO_2 concentration are already required for gas units with integral draft diverters, they are not required for units equipped with draft hoods. In consideration of this, the commenters suggested a 2-year phase in period for gas units equipped with draft hoods since data is not on file for previously tested units and thus additional testing is necessary to develop the new S/F factors. DOE agrees and has incorporated the suggested 2-year phase in period for units equipped with draft hoods. Specifically, the draft hood units shall have the option of using the existing assigned value or today's method for a 2-year period. Thereafter only today's method may be used.

B. Oil Furnaces and Boilers—Based on tests conducted by NBS, it was found that the value of S/F for oil furnaces and boilers is relatively constant, therefore, the assigned value of S/F is not likely to result in marked inaccuracy. Also, oil furnaces and boilers are commonly marketed and sold without a barometric draft regulator. Thus, for those models, a laboratory determination of an S/F value is inappropriate.

Therefore, DOE proposed to allow the use of an assigned value of S/F oil furnaces and boilers and at the manufacturers option a measured value of S/F for oil furnaces and boilers that have the barometric regulator shipped with the unit. As with the gas furnaces and biolers, CO_2 concentrations are used to determine the measured value of S/F.

No opposing comments were received on this issue. Therefore, DOE has adopted the provisions as proposed.

11. Isolated Combustion System (ICS)

The June 17 notice addressed how DOE test procedures should be applied to determine a representative energy efficiency for units installed in an "isolated combustion system." DOE proposed that an assigned jacket loss value of 1 percent may be used, as an option, by all designs of furnaces, if an outdoor rating is made. Since many of the units in ICS installations are designed and intended for indoor installations, this will allow manufacturers to produce indoor and outdoor ratings of any design without increasing testing burden. Additionally, DOE proposed that representations specifically regarding ICS installations be based on the outdoor test method with one half of the jacket loss deduction.

All commenters supported the proposal regarding ICS systems. *See* HI, No. 8, at 6; Carrier, No. 10, at 3; GAMA, No. 12, at 5; and Trane, No. 14, at 3. Therefore, the provisions are adopted as proposed.

In addition, HI and GAMA suggested that this issue further be clarified by revising the definition of "outdoor furnace" in the ASHRAE/ANSI Standard 103–82. *See* HI, No. 8, at 6, and GAMA, No. 12, at 5. Basically, this suggestion is to require a statement on the furnace itself that indicates "intended for outdoor use" if the manufacturer is to consider his design an outdoor furnace in the test procedures. GAMA indicated it would petition the appropriate ASHRAE revision committee regarding this issue.

12. Additional Issues Regarding Furnace Test Procedures

There were a number of additional issues brought up in the comments regarding the furnace test procedures. Although in most cases, these comments were not directly related to the June 17 proposal, they are discussed here for the information of all interested parties.

A. Test Procedure Applicability to Furnaces with High Mass Heat Exchangers—The 20th Century Heating and Ventilating Company (20th Century) believed the June 17 proposal failed to address the company's long-standing objections to the DOE furnace test procedures. *See* 20th Century, No. 2. Twentieth Century company believes that furnaces with higher mass are inherently more efficient than the AFUE predicted by using DOE's "average cycle" methodology. Twentieth Century contends that its design will continue to deliver heat beyond the time frame of the average cycle; thereby keeping the thermostat satisfied and keeping the burner off beyond the time the test procedures assume a furnace should recycle. This postponing of burner on time, called a "free ride" by the commenter, is the basis of the company's contention that its furnace is inherently more efficient than predicted by DOE's test procedures. The fundamental error in this contention is the belief, by the company, that the house thermostat will be satisfied as long as some heat is being delivered by the furnace. This belief is incorrect since the room temperature can decrease in spite of the delivered heat: thus, the thermostat is not satisfied and another burner cycle is needed even though the furnace blower may still be delivering some heat. The DOE test procedures allow for the rating of furnaces with various blower run times. In fact, if the design is such that the furnace would deliver heat in excess of the amount that would be delivered during the average cycle time frame, the test procedures allow ratings based on continuous fan operation.

DOE believes the existing procedures do adequately and fairly allow for the rating of furnaces with high mass heat exchangers. Therefore, DOE sees no need to further address this issue.

B. Deletion of Test Procedures for Electric Furnaces—Trane, Inc. recommended that "the rating of electric furnaces be deleted from the DOE test procedures since they are essentially 100 percent efficient and perpetuation of their rating with resulting FTC labeling is contributing to a waste of industry and government resource time with no benefit to the consumers." *See* Trane, No. 14, at 1.

DOE believes the use of the test procedure itself constitutes little or not testing burden to the manufacturer. Test procedure results and the FTC labeling program provide consumers with useful information. While there is little variation in electric furnace efficiency, the DOE is not deleting the provisions. If the commenter has any proposed revisions to the FTC labeling program, they should be addressed to the FTC.

C. Jacket Loss Testing Accuracy—The existing DOE test procedures refer to the industry standards jacket loss test when determining the efficiency of furnaces installed outdoors. The jacket loss provisions of these standards of the American National Standard Institute (ANSI) (ANSI Z21.47 and ANSI Z91.1) were incorporated into the ANSI/ ASHRAE 103–82 standard. These provisions as published in the ANSI/ ASHRAE 103–82 was criticized by the ETL Laboratories as being extremely vague and subject to varied interpretations. *See* ETL, No. 11, at 1. ETL suggests a more formal and detailed jacket loss test be developed.

DOE will consider this issue as a possible area for future test procedure rulemaking. Any data, analysis, or general comment from interested parties including ANSI are welcome.

Comments were also received that the proposed the jacket loss test failed to assign an adjustment factor, C_j, for finned tube boilers as was done in the existing test procedures. *See* Teledyne Laars and Raypak, Inc., No. 9, at 4, and GAMA, No. 12, at 5. DOE regrets this inadvertent error and has included in today's rule the provision that $C_j = 1.0$ for finned tube boilers.

D. Need to Include a "Preamble" to the Test Procedures—Trane, Teledyne Laars and Raypak and GAMA recommended that a preamble be included in the test procedures to clarify their intent. *See* Trane, No. 14, at 1, Teledyne Laars and Raypak, Inc., No. 9, at 5, and GAMA, No. 12 at, 9. Basically, the preamble would serve to point out the inability of the test procedures to predict the energy performance of a furnace in every installation. Rather, it would point out that their use is for comparison purposes and thus installation variables are only representatively accounted for. DOE agrees with this statement. Thus, this discussion constitutes a "preamble" to the test procedure as requested.

GAMA and Trane suggested DOE provide that: "the procedures are not intended to provide comparisons with other types of heating devices such as heat pumps, space heater, etc.". DOE strongly objects to this additional wording because this cross-product comparison was intended by DOE in developing the different test procedures for the various types of heating devices. Efforts were made by DOE to promulgate consistent test procedures that will allow, to the extent possible, informed purchase decisions across types of heating devices. In addition, the Act requires this when it states the test procedures are to contain measures of energy consumption which are likely to assist consumers in making purchasing decisions.

B. Vented Heater Test Procedure

The vented heater test procedure was prescribed by DOE by notice issued May 2, 1978, 43 FR 20182 (May 10, 1978). Several manufacturers petitioned DOE to expand the vented heater test procedure to include modulating vented heaters and manually controlled vented heaters. Other manufacturers felt that an improved method of testing was needed for vented oil heaters equipped with vaporizing-type burners. In 1980, the *Ad Hoc* Technical Committee of GAMA, presented a simplified testing method to DOE. The method was intended to be an optional procedure that reduces the testing burden on manufacturers. On the basis of the information submitted by the petitioners, information from GAMA, research conducted by NBS, and other available information, DOE proposed to amend the vented heater test procedure to address these concerns in the June 17 proposal. Subsequently, a public hearing was held on June 29, 1983 and comments were received regarding the proposed rule. DOE today is amending the vented heater test procedure to expand the coverage of the test procedure while at the same time reducing the testing burden.

1. Simplified Vented Heater Test Procedure

For vented heaters equipped without manual controls or without thermal stack dampers, DOE proposed a simplified test procedure. The simplified procedures addressed those heaters with modulating controls.

No disapproving comments were received regarding the simplified procedures. *See* GAMA, No. 12, at 10. Therefore, DOE is adopting the simplified procedure as proposed in the June 17 proposal.

Also, since the above mentioned test procedure exceptions BEE–0883 and BEE–0983 (delineated in foot note 3) were granted partially on the basis that no modulating control provisions were included in the existing vented heater test procedures, the effective date of today's rule constitutes the expiration of those exceptions with regard to modulating controls.

2. Manually Controlled Vented Heaters

The June 17 proposal would allow for a determination of efficiency of manually controlled heaters by use of a weighted-average steady-state efficiency. Since a typical manual control allows for several firing rates, this weighted average steady-state efficiency is based on the manually controlled heater operating at 50 percent of maximum heating output rate. However, GAMA testified that since there exist manually controlled heaters that have only a single firing rate and for this design, the averaging of efficiencies method is inappropriate. *See* GAMA, June 29. DOE agrees and today's rule provides that for such designs the weighted average steady-state efficiency is that steady state efficiency when tested at its single firing rate.

Since both modulating controls and manual controls are addressed, the effective date of this final rule constitutes the official expiration of exceptions BEE–0883 and BEE–0983 (delineated in footnote 3).

3. Vented Heaters Equipped With Thermal Stack Dampers

Since no comments objecting to the June 17 proposal for testing of vented heaters with thermal dampers were received, DOE is adopting the proposed provisions in today's final rule.

4. Floor Furnaces

Floor furnaces are a class of vented heaters that are specifically designed to be installed in a crawl space under a home. GAMA suggested that the similar provisions allowed ICS furnaces be allowed for floor furnaces. Specifically, ICS furnaces are allowed an assigned jacket loss of 1 percent and an adjustment factor to account for outdoor and cycling conditions of 1.7. GAMA asks that floor furnaces be allowed an assigned jacket loss of 3 percent and an adjustment factor of 1.7. *See* GAMA, No. 12, at 12.

NBS has reviewed these comments and recommends that the jacket loss continue to be required to be measured for floor furnaces since reduced jacket losses represent the single most important improvement available to floor furnaces. Allowing an assigned value reduces the incentive for improving jacket losses. Consequently, DOE is not allowing an assigned jacket loss for floor furnaces.

Regarding the issue of a lower adjustment factor for floor furnaces, DOE agrees that some reduction of adjustment factor is appropriate for reasons similar to ICS's (i.e. not entirely outside, protected from the wind, etc.). However, DOE believes that representatively, floor furnace installations more closely resemble outdoor installations than ICS installations. Therefore, the appropriate adjustment factor for floor furnace jacket loss should be between that which is allowed for ICS furnaces (1.7) and what is allowed for outdoor vented heaters (3.93). The factor of 2.8 represents the midpoint of these two cases.

C. Unvented Heater Test Procedures

A test procedure for unvented heaters, using electricity, natural gas, or propane, was proposed by DOE on May 4, 1977. 42 FR 23860 (May 11, 1977). A test procedure for electric heaters was prescribed by DOE on May 2, 1978. 43 FR 20128 (May 10, 1978). A final test procedure was not prescribed for unvented natural and propane gas heaters at that time because the Consumer Product Safety Commission (CPSC) proposed to ban the sale of these heaters. 43 FR 6235 (February 14, 1978). CPSC has issued a safety standard in place of a sales ban (16 CFR Part 1212). Today, DOE is prescribing a test procedure appropriate for unvented natural and propane gas heaters as proposed.

In addition, DOE is today prescribing a test procedure for unvented kerosene heaters as proposed. Kerosene heaters were not considered during the previous rulemaking process essentially because these heaters were not widely marketed at the time of the original proposal. DOE believes that a test procedure for kerosene heaters is presently needed since these heaters are now widely marketed.

All comments received regarding these prodedures approved of the provisions as proposed. In particular, the kerosene industry elaborated on the appropriateness of the implied 100 percent fuel efficiency. The Kerosun Company testified that since the operation of an unvented heater does not cause an additional infiltration loss to the home, and since the combustion of the fuel is essentially complete, the implied 100 percent fuel efficiency is entirely appropriate. *See* Kerosun, Inc. June 29. Therefore, based on this testimony and due to the fact that no opposing testimony was received, DOE is prescribing today the provisions that were proposed for these types of heaters.

Arizona Public Service Company (APSC), a public utility, generally supported the proposed amendments for unvented heaters but commented upon the unsafe nature of unvented gas-fired room heaters. *See* APSC, No. 13. The safety of such heaters is not within the jurisdiction of DOE.

D. Estimated Operating Cost for Vented and Unvented Heaters

For vented and unvented heaters, DOE is adopting the proposed method to determine an estimated operating cost per million British thermal units (Btu) output. In the past, several commenters expressed concern over the validity of an estimated annual operating cost for vented and unvented heaters. Most felt that any selection of a representative hours of annual use would be inappropriate for these heaters considering the large variability involved. Secondly, an appropriate efficiency determination was needed for vented heaters with modulating controls. As with furnaces, heaters with modulating controls would have a variable efficiency and operating costs depending on the extent of oversizing.

A valid estimated annual operating cost method for modulating vented heaters would require substantial changes in order to properly consider the effects of oversizing. The changes would require additional calculations for the weighted-average efficiency because the fraction of time that the heater would operate in each mode would depend on the extent of oversizing and on the ratio of minimum to maximum heat output rates. The changes would be similar to today's amendments for modulating furnaces and boilers discussed above.

The variable annual operating cost method was originally developed for vented heaters under the premise that the cost data would be required for the FTC labeling program. The FTC has excluded vented heaters from the labeling program. Therefore, DOE sees no need to expand the estimated annual operating cost calculations for vented heaters.

DOE believes that for vented and unvented heaters the best economic measure to assist consumers in their purchasing decisions is the estimated operating cost per million Btu output. For vented heaters, the estimated cost is determined by using the measured output, the representative unit cost of energy and the annual fuel utilization efficiency (which may be determined from the simplified test procedure proposed today). For unvented heaters, the estimated cost is determined by using the measured output, the representative unit cost of energy and the implied efficiency of 100 percent.

At the public hearing, GAMA and Kerosun, Inc. expressed support for the cost per million Btu's measure. No comments opposing the measure were received. *See* GAMA, June 29; Kerosun, June 29. Therefore, DOE is today prescribing this measure for both unvented and vented home heating equipment.

However, GAMA thought it appropriate that in addition to cost per million Btu's, an hourly operating cost be included for vented heaters as is currently included in electric unvented heaters. DOE sees little merit in such a measure for vented heaters since most vented heaters have modulating type controls and, therefore, various hourly operating costs. Accordingly, a consumer could be misled by this measure if comparisons are made across various firing rates. DOE feels that such comparisons should be avoided and is, therefore, not including them in today's regulations for all types of heaters.

A number of commenters pointed out an apparent deficiency in the measures provided for vented heaters. Although a regulation to determine the operating cost for heaters which use both fossil fuel and electricity was proposed for unvented heaters, no such regulation was proposed for vented heaters. This was an oversight on DOE's part and consequently, today's rule includes a regulation to determine operating cost for such heaters in both the unvented and vented heater subparagraphs.

E. Miscellaneous

After careful consideration of all of the comments and further consultation with NBS, DOE has made some editorial and minor technical changes to the published proposal in today's final rule. For instance, an equals sign (=) is added to the first expression in section 4.9 of Appendix N.

III. PROCEDURAL MATTERS

A. Environmental Review

Pursuant to Section 7(c)(2) of the Federal Energy Administration Act of 1974, a copy of the proposed notice was submitted to the Administrator of the Environmental Protection Agency (EPA) for his comments concerning the impact of this proposal on the quality of the environment. EPA responded by letter with no comment on September 28, 1983.

In addition, the Department has reviewed today's final rule in accordance with the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.), the Council of Environmental Quality Regulations implementing the procedural provisions of NEPA (40 CFR Part 1500 et seq.), and the Department's own NEPA guidelines (45 FR 20694, March 28, 1980, as amended by 47 FR 7976, Feb. 23, 1982) to determine if an environmental impact statement (EIS) or an environmental assessment (EA) is required.

Today's final rule serves only to standardize the measurement of energy usage for furnaces and other home heating equipment. The action of prescribing these revised test procedures will not result in any environmental impacts. Because it is clear that today's final rule is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA, DOE has determined that neither an EA nor an EIA is required.

B. Regulatory Impact Review

The final rule has been reviewed in accordance with Executive Order 12291 which directs that all regulations achieve their intended goals without imposing unnecessary burdens on the economy, on individuals, on public or private organizations, or State and local governments. The Executive Order also requires that regulatory impact analyses be prepared for "major rules." The Executive Order defines a major rule as any regulation that is likely to result in: (1) An annual effect on the economy of $100 million or more; (2) a major increase in costs or prices for consumers, individual industries, Federal, State, or local government agencies, or geographic regions; or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of the United States-based enterprises to compete with foreign-based enterprises in domestic or export markets.

This final rule would only make minor changes in the test procedures for furnaces and other home heating equipment. Therefore, DOE has determined that this final rule does not come within the definition of a major rule.

In accordance with Section 3(c)(3) of the Executive Order, which applies to rules other than major rules, the final rule was submitted to OMB for review without a regulatory impact analysis. This rule has been reviewed by OMB in accordance with the procedures applicable to rules other than major rules.

C. Small Entity Review

The Regulatory Flexibility Act (Pub. L. 96–354) requires that an agency prepare a final regulatory analysis to be available at the time the final rule is published. This requirement does not apply if the agency "certifies that the final rule will not * * * have a significant economic impact on a substantial number of small entities."

In the June 17 proposal, DOE certified, pursuant to Section 605(b) of the Regulatory Flexibility Act, that the proposal, if promulgated, would not have a significant economic impact on a substantial number of small entities. All commenters were generally supportive of the proposal and no commenter took issue with DOE's certification. Accordingly, DOE certifies that this rule will not have a significant economic impact on a substantial number of small entities.

List of Subjects in 10 CFR Part 430

Administrative practice and procedure, Energy conservation, Household appliances.

(Energy Policy and Conservation Act of December 22, 1975, Pub. L. 94-163, Sec. 323(a))

Issued in Washington, D.C., March 7, 1984.

Pat Collins,

Acting Assistant Secretary, Conservation and Renewable Energy.

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

Provisions of 10 CFR Part 430, § 430.2, § 430.22, Appendix G, Appendix N, and Appendix O are amended as follows:

1. Section 430.2 definition of "unvented home heating equipment" is revised and definitions of "Kerosene," "Unvented gas heater," and "unvented oil heater" are added in alphabetical order to read as follows:

§ 430.2 Definition.

* * * * *

"Kerosene" means No. 1 fuel oil with a viscosity meeting the specifications as specified in UL-730-1974, section 36.9 and in tables 2 and 3 of ANSI Standard Z91.1-1972.

* * * * *

"Unvented gas heater" means an unvented, self-contained, free-standing, nonrecessed gas-burning appliance which furnishes warm air by gravity or fan circulation.

"Unvented home heating equipment" means a class of home heating equipment, not including furnaces, used for the purpose of furnishing heat to a space proximate to such heater directly from the heater and without duct connections and includes electric heaters and unvented gas and oil heaters.

"Unvented oil heater" means an unvented, self-contained, free-standing, nonrecessed oil-burning appliance which furnishes warm air by gravity or fan circulation.

* * * * *

§ 430.22 [Amended]

2. Section 430.22 is amended by revising paragraphs (g), (n) and (o) to read as follows:

* * * * *

(g) *Unvented home heating equipment.* (1) The estimated annual operating cost for primary electric heaters, shall be the product of: (i) The average annual electric energy consumption in kilowatt-hours per year, determined according to section 3.1 of Appendix G of this subpart and (ii) the representative average unit cost in dollars per kilowatt-hour as provided pursuant to section 323(b)(2) of the Act, the resulting product then being rounded off to the nearest dollar per year.

(2) The estimated regional annual operating cost for primary electric heaters, shall be the product of: (i) The regional annual electric energy consumption in kilowatt-hours per year for primary heaters determined according to section 3.2 of Appendix G of this subpart and (ii) the representative average unit cost in dollars per kilowatt-hour as provided pursuant to section 323(b)(2) of the Act, the resulting product then being rounded off to the nearest dollar per year.

(3) The estimated operating cost per million Btu output shall be—

(i) For primary and supplementary electric heaters and unvented gas and oil heaters without an auxiliary electric system, the product of: (A) One million; and (B) the representative unit cost in dollars per Btu for natural gas, propane, or oil, as provided pursuant to section 323(b)(2) of the Act as appropriate, or the quotient of the representative unit cost in dollars per kilowatt-hour, as provided pursuant to section 323(b)(2) of the Act, divided by 3,412 Btu per kilowatt hour, the resulting product then being rounded off to the nearest 0.01 dollar per million Btu output; and

(ii) For unvented gas and oil heaters with an auxiliary electric system, the product of: (A) The quotient of one million divided by the rated output in Btu's per hour as determined in 3.4 of appendix G of this subpart; and (B) the sum of: (*1*) The product of the maximum fuel input in Btu's per hour as determined in 2.2. of this appendix times the representative unit cost in dollars per Btu for natural gas, propane, or oil, as appropriate, as provided pursuant to section 323(b)(2) of the Act, plus (*2*) the product of the maximum auxiliary electric power in kilowatts as determined in 2.1 of appendix G of this subpart times the representative unit cost in dollars per kilowatt-hour as provided pursuant to section 323(b)(2) of the Act, the resulting quantity shall be rounded off to the nearest 0.01 dollar per million Btu output.

(4) The rated output for unvented heaters is the rated output as determined according to either sections 3.3 or 3.4 of Appendix G of this subpart, as appropriate, with the result being rounded to the nearest 100 Btu per hour.

(5) Other useful measures of energy consumption for unvented home heating equipment shall be those measures of energy consumption for unvented home heating equipment which the Secretary determines are likely to assist consumers in making purchasing decisions and which are derived from the application of Appendix G of this subpart.

* * * * *

(n) *Furnaces.* (1) The estimated annual operating cost for furnaces is the sum of: (i) The product of the average annual fuel energy consumption, in Btu's per year for gas or oil furnaces or in kilowatt-hours per year for electric furnaces, determined according to section 4.8 or 4.10 of Appendix N of this subpart, respectively, and the representative average unit cost in dollars per Btu for gas or oil, or dollars per kilowatt-hour for electric, as appropriate, as provided pursuant to section 323(b)(2) of the Act, plus (ii) the product of the average annual auxiliary electric energy consumption in kilowatt-hours per year determined according to section 4.9 of Appendix N of this subpart, and the representative average unit cost in dollars per kilowatt-hour as provided pursuant to section 323(b)(2) of the Act, the resulting sum then being rounded off to the nearest dollar per year. (For furnaces which operate with variable inputs, an estimated annual operating cost is to be calculated for each degree of oversizing specified in section 4 of Appendix N of this subpart.)

(2) The annual fuel utilization efficiency for furnaces, expressed in percent, is the ratio of annual fuel output of useful energy delivered to the heated space to the annual fuel energy input to the furnace determined according to section 4.6 of Appendix N of this subpart for gas and oil furnaces and determined in accordance with section 4.1 of Appendix N of this subpart for electric furnaces.

(3) The estimated regional annual operating cost for furnaces is the sum of: (i) The product of the regional annual fuel energy consumption in Btu's per year for gas or oil furnaces or in kilowatt-hours per year for electric

furnaces, determined according to section 4.11 or 4.13 of Appendix N of this subpart, respectively, and the representative average unit cost in dollars per Btu for gas or oil, or dollars per kilowatt-hour for electric, as appropriate, as provided pursuant to section 323(b)(2) of the Act, plus (ii) the product of the regional annual auxiliary electrical energy consumption in kilowatt-hours per year, determined according to section 4.12 of Appendix N of this subpart, and the representative average unit cost in dollars per kilowatt-hour as provided pursuant to section 323(b)(2) of the Act, the resulting sum then being rounded off to the nearest dollar per year.

(4) The energy factor for furnaces, expressed in percent, is the ratio of annual fuel output of useful energy delivered to the heated space to the total annual energy input to the furnace determined according to section 4.14 of Appendix N of this subpart.

(5) Other useful measures of energy consumption for furnaces shall be those measures of energy consumption which the Secretary determines are likely to assist consumers in making purchasing decisions and which are derived from the application of Appendix N of this subpart.

(o) *Vented home heating equipment.*

(1) The annual fuel utilization efficiency for vented home heating equipment, expressed in percent, which is the ratio of the annual fuel output of useful energy delivered to the heated space to the annual fuel energy input to the vented heater, shall be determined either according to section 4.1.17 of Appendix O of this subpart for vented heaters without either manual controls or thermal stack dampers; according to section 4.2.6 of Appendix O of this subpart for vented heaters equipped with manual controls; or according to section 4.3.7 of Appendix O of this subpart for vented heaters equipped with thermal stack dampers.

(2) The estimated operating cost per million Btu output for vented heaters without an auxiliary electric system shall be the product of: (i) One hundred; (ii) the quotient of one million Btu output divided by the annual fuel utilization efficiency as determined in paragraph (o) (1) and (iii) the representative unit cost in dollars per Btu for natural gas, propane, or oil, as appropriate, as provided pursuant to section 323(b)(2) of the Act, the resulting product shall be rounded to the nearest 0.01 dollar per million Btu output.

(3) The estimated operating cost per million Btu output for gas or oil vented home heating equipment with an auxiliary electric system shall be the product of: (A) The quotient of one million Btu divided by the sum of: (*1*) The product of the maximum fuel input in Btu's per hour as determined in 3.1.1 or 3.1.2 of Appendix 0 of this subpart times the annual fuel utilization efficiency in percent as determined in 4.1.17, 4.2.6, or 4.3.7 of this appendix as appropriate divided by 100, plus (*2*) the product of the maximum electric power in watts as determined in 3.1.3 of Appendix 0 of this subpart times the quantity 3.412; and (B) of the sum of: (*1*) the product of the maximum fuel input in Btu's per hour as determined in 3.1.1 of this appendix times the representative unit cost in dollars per Btu for natural gas, propane, or oil, as appropriate, as provided pursuant to section 323(b)(2) of the Act; plus (*2*) the product of the maximum auxiliary electric power in kilowatts as determined in 3.1.3 of Appendix O of this subpart times the representative unit cost in dollars per kilowatt-hour as provided pursuant to section 323(b)(2) of the Act, the resulting quantity shall be rounded off to the nearest 0.01 dollar per million Btu output.

(4) Other useful measures of energy consumption for vented home heating equipment shall be those measures of energy consumption which the Secretary determines are likely to assist consumers in making purchasing decisions and which are derived from the application of Appendix O of this subpart.

3. Appendix G. to Subpart B of Part 430 is revised to read as follows:

Appendix G to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Unvented Home Heating Equipment

1. *Testing conditions.*

1.1 *Installation.*

1.1.1 *Electric heater.* Install heater according to manufacturer's instructions. Heaters shall be connected to an electrical supply circuit of nameplate voltage with a wattmeter installed in the circuit. The wattmeter shall have a maximum error not greater than one percent.

1.1.2 *Unvented gas heater.* Install heater according to manufacturer's instructions. Heaters shall be connected to a gas supply line with a gas displacement meter installed between the supply line and the heater according to manufacturer's specifications. The gas displacement meter shall have a maximum error not greater than one percent. Gas heaters with electrical auxiliaries shall be connected to an electrical supply circuit of nameplate voltage with a wattmeter installed in the circuit. The wattmeter shall have a maximum error not greater than one percent.

1.1.3 *Unvented oil heater.* Install heater according to manufacturer's instructions. Oil heaters with electric auxiliaries shall be connected to an electrical supply circuit of nameplate voltage with a wattmeter installed in the circuit. The wattmeter shall have a maximum error not greater than one percent.

1.2 *Temperature regulating controls.* All temperature regulating controls shall be shorted out of the circuit or adjusted so that they will not operate during the test period.

1.3 *Fan controls.* All fan controls shall be set at the highest fan speed setting.

1.4 *Energy supply.*

1.4.1 *Electrical supply.* Supply power to the heater within one percent of the nameplate voltage.

1.4.2 *Natural gas supply.* For an unvented gas heater utilizing natural gas, maintain the gas supply to the heater with a normal inlet test pressure immediately ahead of all controls at 7 to 10 inches of water column. The regulator outlet pressure at normal supply test pressure shall be approximately that recommended by the manufacturer. The natural gas supplied should have a higher heating value within ± 5 percent of 1,025 Btu's per standard cubic foot. Determine the higher heating value, in Btu's per standard cubic foot, for the natural gas to be used in the test, with an error no greater than one percent. Alternatively, the test can be conducted using "bottled" natural gas of a higher heating value within ± 5 percent of 1,025 Btu's per standard cubic foot as long as the actual higher heating value of the bottled natural gas has been determined with an error no greater than one percent as certified by the supplier.

1.4.3 *Propane gas supply.* For an unvented gas heater utilizing propane, maintain the gas supply to the heater with a normal inlet test pressure immediately ahead of all controls at 11 to 13 inches of water column. The regulator outlet pressure at normal supply test pressure shall be that recommended by the manufacturer. The propane supplied should have a higher heating value of within ± 5 percent of 2,500 Btu's per standard cubic foot. Determine the higher heating value in Btu's per standard foot, for the propane to be used in the test, with an error no greater than one percent. Alternatively, the test can be conducted using "bottled" propane of a higher heating value within ± 5 percent of 2,500 Btu's per standard cubic foot as long as the actual higher heating value of the bottled propane has been determined with an error no greater than one percent as certified by the supplier.

1.4.4 *Oil supply.* For an unvented oil heater utilizing kerosene, determine the higher heating value in Btu's per gallon with an error no greater than one percent. Alternatively, the test can be conducted using a tested fuel of a higher heating value within ± 5 percent of 137,400 Btu's per gallon as long as the actual higher heating value of the tested fuel has been determined with an error no greater than one percent as certified by the supplier.

1.5 *Energy flow instrumentation.* Install one or more energy flow instruments which measure, as appropriate and with an error no greater than one percent, the quantity of electrical energy, natural gas, propane gas, or oil supplied to the heater.

2. *Testing and measurements.*

2.1 *Electric power measurement.* Establish the test conditions set forth in section 1 of this appendix. Allow an electric heater to warm up for at least five minutes before recording the maximum electric power measurement from the wattmeter. Record the maximum electric power (P_E) expressed in kilowatts.

Allow the auxiliary electrical system of a forced air unvented gas, propane, or oil heater to operate for at least five minutes before recording the maximum auxiliary electric power measurement from the wattmeter. Record the maximum auxiliary electric power (P_A) expressed in kilowatts.

2.2 *Natural gas, propane, and oil measurement.* Establish the test conditions as set forth in section 1 of this appendix. A natural gas, propane, or oil heater shall be operated for one hour. Using either the nameplate rating or the energy flow instrumentation set forth in section 1.5 of this appendix and the fuel supply rating set forth in sections 1.4.2, 1.4.3, or 1.4.4 of this appendix, as appropriate, determine the maximum fuel input (P_F) of the heater under test in Btu's per hour. The energy flow instrumentation shall measure the maximum fuel input with an error no greater than one percent.

3. Calculations.

3.1 *Annual energy consumption for primary electric heaters.* For primary electric heaters, calculate the annual energy consumption (E_E) expressed in kilowatt-hours per year and defined as:

$E_E = 2080(0.77)DHR$

where:

2080 = national average annual heating load hours
0.77 = adjustment factor
DHR = design heating requirement and is equal to P_E /1.2 in kilowatts.
P_E = as defined in 2.1 of this appendix
1.2 = typical oversizing factor for primary electric heaters

3.2 *Annual energy consumption for primary electric heaters by geographic region of the United States.* For primary electric heaters, calculate the annual energy consumption by geographic region of the United States (E_R) expressed in kilowatt-hours per year and defined as:

$E_R = HLH(0.77)(DHR)$

where:

HLH = heating load hours for a specific region determined from Figure 1 of this appendix in hours
0.77 = as defined in 3.1 of this appendix
DHR = as defined in 3.1 of this appendix

3.3 *Rated output for electric heaters.* Calculate the rated output (Q_{out}) for electric heaters, expressed in Btu's per hour, and defined as:

$Q_{out} = P_E$ (3,412 Btu/kWh)

where:

P_E = as defined in 2.1 of this appendix

3.4 *Rated output for unvented heaters using either natural gas, propane, or oil.* For unvented heaters using either natural gas, propane, or oil equipped without auxiliary electrical systems, the rated output (Q_{out}), expressed in Btu's per hour, is equal to P_F, as determined in section 2.2 of this appendix.

For unvented heaters using either natural gas, propane, or oil equipped with auxiliary electrical systems, calculate the rated output (Q_{out}), expressed in Btu's per hour, and defined as:

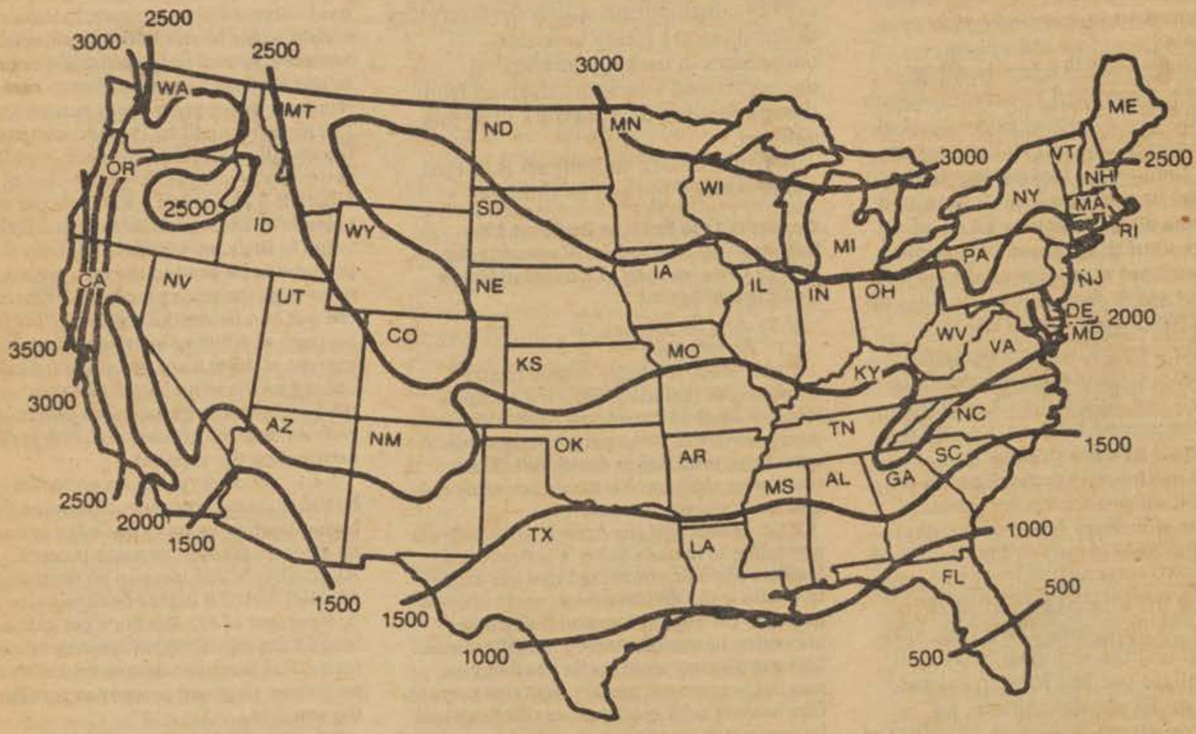
$Q_{out} = P_F + P_A$ (3,412 Btu/kWh)

where:

P_F = as defined in 2.2 of this appendix in Btu/hr
P_A = as defined in 2.1 of this appendix in Btu/hr

FIGURE I

Heating Load Hours (HLH) for the United States and Territories



This map is reasonably accurate for most parts of the United States but is necessarily highly generalized and consequently not too accurate in mountainous regions, particularly in the Rockies.

Alaska — 3500 HLH
Hawaii and Territories — O HLH

4. Appendix N to Subpart B of Part 430 is revised to read as follows:

Appendix N to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Furnaces

1. *Definitions.* Definitions shall include the definitions specified in section 3.0 of ANSI/ASHRAE 103–82 and the following additional definitions:

1.1 "ASHRAE" means the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

1.2 "ANSI/ASHRAE 103-82" means the test standard published in 1982 by ASHRAE, approved by the American National Standards Institute (ANSI) on June 21, 1983 and titled "Methods of Testing for Heating Seasonal Efficiency of Central Furnaces And Boilers."

1.3 "Electro-mechanical stack damper" means a type of stack damper which is operated by electrical and/or mechanical means.

1.4 "Isolated combustion system" means an installation in which a furnace is installed indoors and all combustion and ventilation air is admitted through grills or ducts from outdoors and (all such air) does not communicate with air in the conditioned space.

1.5 "Modulating control" means either a step modulating or a "two-stage control"

1.6 "Reduced heat input rate" means the factory adjusted lowest reduced heat input rate for furnaces equipped with either two stage thermostats or step-modulating thermostats.

1.7 "Single stage thermostat" means a thermostat that cycles a burner from the maximum heat input rate and off.

1.8 "Step-modulating control" means a modulating control that cycles a burner from the reduced input rate to off if the heating load is light. If a higher heating load is encountered which cannot be met with the reduced input rate, the control either gradually increases or steps up the input rate to meet the higher heating load. At that point if a lower heating load is encountered, the control either gradually decreases or steps down to a lower rate, or gradually increases the heat input to meet any higher heating load that cannot be met with the low firing rate.

1.9 "Thermal stack damper" means a type of stack damper which is dependent for operation exclusively upon the direct conversion of thermal energy of the stack gases into closure of the damper.

1.10 "Two stage control" means a modulating control that cycles a burner from reduced heat input rate and off or cycles a burner at the maximum heat input rate and off.

2.0 *Testing conditions.* The testing conditions shall be as specified in section 8 of ANSI/ASHRAE 103–82 with the exception of section 8.4.2.3, and the inclusion of the following additional testing conditions:

2.1 *Gas burner adjustment at maximum input rate.* The following paragraph is in addition to the requirements specified in section 8.4.1.1 of ANSI/ASHRAE 103–82:

For gas fueled furnaces and boilers equipped with modulating type controls, adjust the controls to operate the unit at the maximum fuel input rate. Set the thermostat control to the maximum setting. Start the furnace or boiler by turning the safety control valve to the "on" position. Use a supply water temperature for boilers that will allow for continuous operation without shut off by the thermostat control.

2.2 *Gas burner adjustment at reduced input rate.* The following paragraph is in addition to the requirements specified in section 8.4.1.1 of ANSI/ASHRAE 103–82:

For gas fueled furnaces and boilers equipped with modulating type thermostat controls, adjust the controls to operate the unit at the reduced fuel input rate. Set the thermostat control to the lowest setting that does not cause the burner to cycle on and off. Start the furnace or boiler by turning the safety control valve to the "on" position. Use supply water temperature for boilers that will allow for continuous operation without shut off by the thermostat control. If necessary, supply water may be increased above 120° F in order to maintain continuous operation at the reduced setting.

2.3 *Gas and oil fueled low pressure steam and hot water boilers (including direct vent systems).* The following paragraphs are in place of section 8.4.2.3 of ANSI/ASHRAE 103–82:

For non-condensing hot water boilers, the water flow rate shall be adjusted to produce a water temperature rise, during the steady-state test described in section 9.1 of ANSI/ASHRAE 103–82, of 19° F–24° F. During the steady-state and heat-up tests, the hot water boiler shall be supplied with water having a temperature of at least 120° F but not more than 124° F.

For steam boilers, the pressure shall be at atmospheric or at a pressure not exceeding 2 psig during the steady-state test.

3.0 *Test procedure.* Testing and measurements shall be as specified in section 9 of ANSI/ASHRAE 103–82 with the exception of sections 9.2.2 and 9.3.2, and the inclusion of the following additional procedures:

3.1 *Gas fueled gravity furnaces, forced air central furnaces, and low pressure steam and hot water boilers (including direct vent systems, excluding condensing furnaces or boilers).* The following paragraphs are in addition to the requirements specified in section 9.1.1 of ANSI/ASHRAE 103–82:

For all gas fueled furnaces and boilers, the steady-state efficiency shall be determined at the maximum fuel input rate measured in accordance with sections 2.1 of this appendix and section 9.1.1 of ANSI/ASHRAE 103–82. Also, for gas fueled furnaces and boilers equipped with either two stage thermostats or step-modulating thermostats, the steady-state efficiency shall also be determined at the reduced fuel input rate measured in accordance with sections 2.2 of this appendix and section 9.1.1 of ANSI/ASHRAE 103–82.

In addition, for gas fueled furnances and boilers equipped with draft hoods, measure CO_2 in stack after dilution during the steady state condition.

3.2 *Flue temperature measurements—cool down test.* The following paragraphs are in addition to the requirements specified in section 9.2 of ANSI/ASHRAE 103–82:

For furnaces and boilers equipped with step-modulating thermostats, the cool down test shall be conducted after steady-state conditions have been reached at the reduced input rate, as specified in section 2.2 of this appendix. For furnaces and boilers equipped with two stage controls, separate cool down tests shall be conducted after steady-state conditions have been reached at both the reduced and maximum fuel input rates.

3.3 *Gas and oil fueled boilers—cool down test.* The following paragraphs are in place of the requirements specified in section 9.2.2 of ASHRAE 103–82:

After steady-state testing has been completed, turn the main burner(s) off and measure the flue gas temperature at 3.75 ($T_{F.OFF(t3)}$) and 22.5 ($T_{F.OFF(t4)}$) minutes after the burner shuts off, using the thermocouple grid described above. During this off period for units that do not have pump delay after shut-off, no water shall be allowed to circulate through the hot water boilers. For units that have pump delay on shut-off, except those having pump controls sensing water temperature, the pump shall be stopped by the unit control and the time, t^+, between burner shut-off and pump shut-off shall be measured within one second accuracy. For units having pump delay controls which sense water temperature, the pump shall be operated for 15 minutes and t^+ shall be 15 minutes. While the pump is operating, the inlet water temperature and flow rate shall be maintained at the same values as used during the preceding steady-state test.

Make a third flue gas temperature measurement 45 minutes after the burner shuts off to determine the off-period minimum flue gas temperature ($T_{F.OFF(\infty)}$).

During this cool down test, measure the energy input rate to the pilot light (Q_P), if the unit is so equipped, to within an error no larger than ± 3 percent. Record all measured values. For oil fueled units not equipped with stack dampers, maintain the draft in the flue within the same ranges specified in section 9.2.1 of ANSI/ASHRAE 103–82. For direct vent systems with flue dampers or boilers equipped with both stack dampers and barometric dampers, close the flue or stack damper during the cool down test.

3.4 *Flue gas temperature measurements—heat-up test.* The following paragraph is in addition to the requirement specified in section 9.3 of ANSI/ASHRAE 103–82.

For furnaces and boilers equipped with step-modulating thermostats, the heat-up test shall be conducted at the reduced fuel input rate, as specified in section 2.2 of this appendix. For furnaces and boilers equipped with two stage controls, separate heat-up tests shall be conducted at both the reduced and maximum fuel input rates.

3.5 *Gas and oil fueled boilers.* The following paragraph is in place of the requirements specified in section 9.3.2 of ANSI/ASHRAE 103–82.

Fifty minutes or more after the main burner(s) is turned off for the cool down test, turn on the steam or hot water boiler and measure the flue gas temperature at 1.0 ($T_{f\text{-}on(t1)}$) and 5.5 ($T_{f.on(t2)}$) minutes after the main burners are turned on. The pump circulating the water through the hot water boiler shall be started simultaneously with the main burner(s). The water flow rate shall be the same as that maintained during the steady-state test described in section 9.1 of ANSI/ASHRAE 103–82. During the heat-up test for oil fired boilers maintain the draft in the flue pipe within ± 0.01 inch of water column of the manufacturer's recommended on-period draft. Record the measured temperatures.

3.6 *Direct measurement of condensate.* For condensing furnaces and boilers, the condensate heat loss shall be determined either by the method specified in section 11.2.33 of ANSI/ASHRAE 103–82 or by the following test procedures:

Control devices shall be installed to allow cyclical operation of the unit and return water or air flows as described in sections 9.2 and 9.3 of ANSI/ASHRAE 103–82 and sections 3.2, 3.3, 3.4 and 3.5 of this appendix. The test unit shall be leveled prior to test. Operating times and beginning and end of condensate collection shall be determined by a clock or timer with a minimum resolution of one second. Humidity of the room air shall, at no time, exceed 80 percent.

Control of on or off operation actions shall be within ± 6 seconds of the scheduled time. Condensate drain lines shall be attached to the unit as specified in the manufacturer's installation instructions. A continuous downward slope of drain lines from the unit shall be maintained. Additional precautions shall be taken to facilitate uninterrupted flow of condensate during the test.

The flue pipe installation must not allow condensate formed in the flue pipe to flow back into the unit. An initial downward slope from the unit's exit, an offset with a drip leg, annular collection rings, or drain holes must be included in the flue pipe installation without disturbing normal flue gas flow, as specified in section 7.2.2 of ANSI/ASHRAE 103–82. Flue gases should not flow out of the drain with the condensate.

Collection-containers must be glass or polished stainless steel, so removal of interior deposits can be easily made. The collection-container shall have a vent opening to the atmosphere.

The scale for measuring the containers and sample condensate mass shall be calibrated with an error no larger than ± 0.5 percent over the range of interest.

The condensing furnace or boiler shall be tested by the flue loss method in accordance with the provisions for condensing units, as specified in section 9 of ASNI/ASHRAE 103–82 and section 3 of this appendix. The condensate collection-containers shall be dried prior to each use and shall be at room ambient temperature prior to a sample collection. Tare weight of the collection-container must be measured and recorded prior to each sample collection.

The unit should be operated in a cyclical manner until flue gas temperatures at the end of each on-cycle are within 5° F (2.8° C) of each other for two consecutive cycles. On-cycle and off-cycle times are listed in Table 2 of this appendix. Begin three test cycles. Return air temperature for furnaces shall be as specified in section 9 of ANSI/ASHRAE 103–82 and section 3 of this appendix. Return water temperature for boilers shall be as specified in section 2.3 of this appendix. Operation of the furnace blower or boiler pump shall conform to the time delay requirements specified in sections 9.2 and 9.3 of ANSI/ASHRAE 103–82 and sections 3.2, 3.3, 3.4, and 3.5 of this appendix for cool down and heat up tests. Operation of the boiler pump shall conform to the time delay requirements specified in section 3.3 of this appendix.

Begin condensate collection at one minute before the on-cycle period of the first test cycle. The container shall be removed one minute before the end of each off-cycle period of the sixth test cycle. Condensate mass shall be measured for each test cycle.

Fuel input shall be recorded during the entire test period starting at the beginning of the on-time period of the first cycle to the beginning of the on-time period of the second cycle, etc., for each of the test cycles. Fuel higher heating value (HHV), temperature and pressures necessary for determining fuel energy input (Q_c) shall be recorded. The fuel quantity and HHV shall be measured with errors no greater than one percent. Determine the mass of condensate for each cycle (m_c) in pounds. If at the end of three cycles, the sample standard deviation is within 20% of the mean value for 3 cycles use total condensate collected in the three cycles as m_c, if not, continue collection for an additional three cycles and use the total condensate collected for the six cycles as m_c. Determine the fuel energy input during the three or six test cycles (Q_c) expressed in Btu.

Begin a steady-state condensate collection after steady-state conditions have been achieved as specified in section 8 of ANSI/ASHRAE 103–82 and section 2 of this appendix. The steady-state collection period shall be 30 minutes. Condensate mass shall be measured immediately at the end of the collection period to prevent evaporation loss from the sample. Fuel input shall be recorded for the one hour steady-state test period. Fuel Higher Heating Value (HHV), temperature and pressures necessary for determining fuel energy input $Q_{C,SS}$ will be observed and recorded in Btu's. The fuel quantity and HHV shall be measured with errors no greater than one percent. Determine the mass of condensate for the steady-state test, $m_{C,SS}$, in pounds by subtracting the tare container weight from the total container and condensate weight measured at the end of the 30 minutes test period.

3.7 *Direct measurement of off-cycle losses testing method.* Reserved.

3.8 *Direct measurement of the S/F factors for oil furnaces and boilers.* For oil furnaces and boilers that are marketed and sold with attached barometric dampers, the S/F factor shall be determined either by using assigned factors in Table 2 of ANSI/ASHRAE 103–82 or by the following test procedure:

To directly measure the S/F factor, seal the barometric damper plate in the closed position. Operate the furnace or boiler until steady-state temperatures are attained. Adjust the draft in the flue within one foot of the heat exchanger exit to be between 0.075 and 0.085 inch water column. A mechanical draft inducer or a natural draft developed by adjusting the height of the test stack may be used. Remove the seal from the barometric damper and adjust the damper gate to achieve proper draft, as specified by the manufacturer. If the draft over the fire is specified as a range, adjust the draft to the mid-point of that range.

After steady-state conditions are again achieved with the draft adjusted as specified, measure CO_2 before and after dilution at points marked A and B in Figure 2 of this appendix. To ensure that the sample is well mixed after dilution obtain a representative sample of stack gas by sampling from several points on a horizontal plane through the cross section of the stack. The test setup shown in Figure 2 enhances the mixing of dilution air and flue gases. Alternatively, a straight length of stack or other flue piping arrangement may be used with stack samples taken sufficiently downstream after dilution in order to obtain a well-mixed sample.

3.9 *Furnaces and boilers that includes small air passages in the flue.* For furnaces and boilers that includes small air passages in the flue where such passage serves a utility other than for draft relief, the air passage shall be open during all tests and the test data shall be reduced as specified in section 4 of this appendix.

These units shall be considered as direct exhaust systems, for the purposes of this test procedure. These provisions shall not apply to systems which allow for air flow through the air passage in excess of 10 percent of maximum steady state total flue flow; in these cases, such passages are to be considered as draft diverters or draft hoods.

4.0 *Calculations.* Calculations shall be as specified in section 11 of ANSI/ASHRAE 103–82 with the exception of section 11.2.6, and the inclusion of the following additional calculations:

4.1 *Annual fuel utilization efficiency for electric furnaces and boilers.* The annual fuel utilization efficiency for electric furnaces and boilers (AFUE) is equal to the heating seasonal efficiency for electric furnaces and boilers ($Effy_{hs,e}$) as defined in section 11.1 of ANSI/ASHRAE 103–82.

4.2. *Average ratio of stack gas mass flow rate to flue gas mass flow rate at steady-state operation.* The following paragraphs are in place of the requirements specified in section 11.2.6 of ANSI/ASHRAE 103–82:

For gas furnaces and boilers with integral draft diverters, calculate the average ratio of stack gas mass flow rate to flue gas mass flow rate at steady-state operation (S/F) defined as:

$$S/F = 1.3\, R_{T,S}/R_{T,F}$$

where:

$R_{T,S}$ = as defined in 11.2.3 of ANSI/ASHRAE 103–82

$R_{T,F}$ = as defined in 11.2.2 of ANSI/ASHRAE 103–82

For gas furnaces and boilers equipped with draft hoods determine the S/F by the method set out above or use the assigned value of 2.4. This alternative method may be used until 24 months from the effective date of the amendment. After that date, the assigned value may not be used and only the method set out above may be used.

For oil furnaces and boilers, S/F shall be 1.40 for units not shipped with barometric dampers or for units shipped with barometric dampers, S/F shall be either 1.40 or determined by:

$S/F = R_{T,S}/R_{T,F}$

where:

$R_{T,S}$ = as defined in 11.2.3 of ANSI/ASHRAE 103–82 in which the value of CO_2 measured in the stack in 3.8 of this appendix is used

$R_{T,F}$ = as defined in 11.2.2 of ANSI/ASHRAE 103–82 in which the value of CO_2 measured in the flue in 3.8 of this appendix is used

4.3 *Optional direct condensate measurement method.* For condensing furnaces and boilers for which the direct measurement of condensate is used, as specified in section 3.6 of this appendix, calculate the part-load efficiency (η_u) and the steady-state efficiency (η_{SS}) expressed as a percent and defined as:

$\eta_u = Effy_{hs} + L_G - L_C$

$\eta_{SS} = Effy_{SS} + L_{G,SS} - L_{C,SS}$

where:

$Effy_{hs}$ = heating seasonal efficiency for non-condensing furnaces and boilers, as defined in 11.2.34 of ANSI/ASHRAE 103–82

L_G = latent heat gain under part-load conditions, as defined in 4.3.1 of this appendix

L_C = part-load heat loss due to the condensate going down the drain and corrected for the fact that the condensate did not go up the flue as heated vapor, as was assumed in determining $L_{S,SS,A}$, as defined in 4.3.2 of this appendix

$Effy_{SS}$ = steady-state efficiency for non-condensing furnaces and boilers, as defined in 11.2.5 of ANSI/ASHRAE 103–82

$L_{G,SS}$ = latent heat gain under steady-state conditions, as defined in 4.3.3 of this appendix

$L_{C,SS}$ = steady-state heat loss due to the condensate going down the drain and corrected for the fact that the condensate did not go up the flue as heated vapor, as was assumed in determining $L_{S,SS,A}$, as defined in 4.3.4 of this appendix

4.3.1 *Latent heat gain under part-load conditions.* Calculate the latent heat gain under part-load conditions (L_G) expressed as a percent and defined as:

$L_G = 100(1053.3)\ m_c/Q_c$

where:

100 = conversion factor to express a decimal as a percent

1053.3 = latent heat vaporization of water, Btu per pound

m_c = as defined in 3.6 of this appendix

Q_c = as defined in 3.6 of this appendix

4.3.2 *Part-load heat loss due to the condensate.* Calculate the part-load heat loss due to the condensate going down the drain and corrected for the fact that the condensate did not go up the flue as heated vapor, as was assumed in determining $L_{S,SS,A}$ (L_C) expressed as a percent and defined as:

$L_C = L_G[1.0(T_{F,SS} - 70) - 0.45(T_{F,SS} - 42)]/1053.3$

where:

L_G = as defined in 4.3.1 of this appendix

1.0 = specific heat of water (liquid), Btu per pound − °F

$T_{F,SS}$ = as defined in 11.2.4 of ANSI/ASHRAE 103–82

70 = assumed average indoor air temperature, °F

0.45 = specific heat of water vapor, Btu per pound − °F

42 = average outdoor temperature corresponding to 5,200 degree day location, °F

1053.3 − Latent heat of vaporization of water, Btu per pound

4.3.3 *Latent heat gain under steady-state conditions.* Calculate the latent heat gain under steady-state conditions ($L_{G,SS}$) expressed as a percent and defined as:

$L_{G,SS} = 100(1053.3)m_{C,SS}/Q_{C,SS}$

where:

100 = conversion factor to express a decimal as a percent

1053.3 = latent heat of vaporization of water, Btu per pound

$m_{C,SS}$ = as defined in 3.6 of this appendix, pound

$Q_{C,SS}$ = as defined in 3.6 of this appendix, Btu

4.3.4 *Steady-state heat loss due to the condensate.* Calculate the steady-state heat loss due to the condensate going down the drain ($L_{C,SS}$) expressed as a percent and defined as:

$L_{C,SS} = L_{G,SS}[1.0(T_{F,SS} - 70) - 0.45(T_{F,SS} - 42)]/1053.3$

where:

$L_{G,SS}$ = as defined in 4.3.3 of this appendix

1.0 = specific heat of water (liquid), Btu per pound − ° F

$T_{F,SS}$ = as defined in 11.2.4 of ANSI/ASHRAE 103–82

70 = assumed average indoor air temperature, ° F

0.45 = specific heat of water vapor, Btu per pound − ° F

42 = average outdoor temperature corresponding to 5200 degree day location, ° F

1053.3 = latent heat of vaporization of water, Btu per pound

4.4 *Direct determination of off-cycle losses for furnaces and boilers equipped with stack dampers.* Reserved

4.5 *Modulating controls.*

4.5.1 *Weighted-average part-load utilization efficiency.* For furnaces and boilers equipped with two stage thermostats, calculate the weighted-average part-load utilization efficiency at each design heating requirement ($\eta_{U,WT}$) expressed as a percent and defined as:

$\eta_{U,WT} = X_1\eta_{U,RED} + X_2\eta_{U,MAX}$

where:

X_1 = fraction of heating load at reduced operating mode, as defined in 4.5.2 of this appendix

$\eta_{U,RED}$ = the part-load efficiency at the reduced fuel input rate and is defined as the heating seasonal efficiency ($Effy_{hs}$) in 11.2.34 of ANSI/ASHRAE 103–82, measured at the reduced fuel input rate and calculated by using the appropriate on and off times as specified from Table 2 of this appendix

X_2 = fraction of heating load at maximum operating mode, as defined in 4.5.3 of this appendix

$\eta_{U,MAX}$ = the part-load efficiency at the maximum fuel input rate and is defined as the heating seasonal efficiency ($Effy_{hs}$) in 11.2.34 of ANSI/ASHRAE 103–82, measured at the maximum fuel input rate and calculated by using the appropriate on and off times as specified from Table 2 of this appendix

For furnaces and boilers equipped with step-modulating thermostats, calculate $\eta_{U,WT}$ expressed as a percent and defined as:

$\eta_{U,WT} = X_1\ \eta_{U,RED} + X_2\ \eta_{U,MOD}$

where:

X_1 = as defined in 4.5.2 of this appendix

$\eta_{U,RED}$ = as defined in 4.5.1 of this appendix

X_2 = as defined in 4.5.3 of this appendix

$\eta_{U,MOD}$ = average part-load efficiency for the modulating mode, as defined in 4.5.8 of this appendix

4.5.2 *Fraction of heating load at reduced operating mode.* Determine the fraction of heating load at the reduced operating mode (X_1) expressed as a decimal and listed in either Figure 4 or Table 3 of this appendix for appropriate values of the balance point temperature (T_C). T_C is defined in section 4.5.4 of this appendix.

4.5.3 *Fraction of heating load at maximum operating mode.* Determine the fraction of heating load at the maximum operating mode (X_2) expressed as a decimal and listed in either Figure 4 or Table 3 of this appendix for appropriate values of the balance point temperature (T_C).

4.5.4 *Balance point temperature.* Calculate the balance point temperature (T_C) which represents a temperature used to apportion the annual heating load between the reduced input cycling mode and either the modulation mode or maximum input cycling mode. T_C is defined as:

$T_C = 65 - [\Delta T_D(1 + \alpha_{DHR})\ [Q_{OUT,RED}/Q_{OUT,MAX}]]$

where:

65 = average outdoor temperature at which a furnace or boiler starts operating, °F

ΔT_D = the difference between the outdoor air temperature where heating is typically required and the outdoor design temperature, the national average temperature difference is 65° F − 5° F or 60° F

5 = outdoor design temperature

α_{DHR} = oversize factor at each design heating requirement, as defined in 4.5.5 of this appendix

$Q_{OUT,RED}$ = heat output rate at the reduced fuel input rate, as defined in 4.5.6 of this appendix

$Q_{OUT,MAX}$ = heat output rate at the maximum fuel input rate, as defined in 4.5.7 of this appendix

4.5.5 *Oversize factor at each design heating requirement.* Calculate the oversize factor at each design heating requirement (α_{DHR}) expressed as a decimal and defined as:

$\alpha_{DHR} = [Q_{OUT,MAX}/DHR] - 1$

where:

$Q_{OUT,MAX}$ = as defined in 4.5.7 of this appendix

DHR = typical design heating requirements, as listed in Table 1 of this appendix

4.5.6 *Heat output rate at the reduced fuel input rate.* Calculate the heat output rate at the reduced fuel input rate ($Q_{OUT.RED}$) defined as:

$$Q_{OUT.RED} = \eta_{SS.RED} Q_{IN.RED}$$

where:

$\eta_{SS.RED}$ = steady-state efficiency at the reduced fuel input rate and is defined as the steady-state efficiency ($Effy_{SS}$) in 11.2.5 of ANSI/ASHRAE 103–82, measured at the reduced fuel input rate

$Q_{IN.RED}$ = the reduced fuel input rate and is defined as Q_{IN} in 11.2.34 of ANSI/ASHRAE 103–82, measured at the reduced fuel input rate

4.5.7 *Heat output rate at the maximum fuel input rate.* Calculate the heat output rate at the maximum fuel input rate ($Q_{OUT.MAX}$) defined as:

$$Q_{OUT.MAX} = \eta_{SS.MAX} Q_{IN.MAX}$$

where:

$\eta_{SS.MAX}$ = steady-state efficiency at the maximum fuel input rate and is defined as the steady-state efficiency ($Effy_{SS}$) in 11.2.5 of ANSI/ASHRAE 103–82, measured at the maximum fuel input rate

$Q_{IN.MAX}$ = the maximum fuel input rate and is defined as $_{IN}$ in 11.2.34 of ANSI/ASHRAE 103–82

4.5.8 *Average part-load efficiency for the modulating mode for furnaces and boilers equipped with step-modulating thermostats.* For furnaces and boilers equipped with step-modulating thermostats and are located in heated spaces, calculate the average part-load efficiency for the modulating mode ($\eta_{U.MOD}$) expressed as a percent and defined as:

$$\eta_{U.MOD} = \eta_{SS.MOD} - L_{I.ON.MOD}$$

where:

$\eta_{SS.MOD}$ = average steady-state efficiency for the modulating mode as defined in 4.5.9 of this appendix

$L_{I.ON.MOD}$ = average on-cycle infiltration heat loss for the modulating mode as defined in 4.5.10 of this appendix

For furnaces and boilers equipped with step-modulating thermostats and are located outside or are in unheated spaces, calculate $\eta_{U.MOD}$ defined as:

$$\eta_{U.MOD} = \eta_{SS.MOD} - C_J L_J$$

where:

$\eta_{SS.MOD}$ = as defined in 4.5.9 of this appendix

C_J = as defined in 4.6 of this appendix

L_J = as defined in 4.6 of this appendix

4.5.9 *Average steady-state efficiency for the modulating mode for furnaces and boilers equipped with step-modulating thermostats.* For furnaces and boilers equipped with step-modulating thermostats, calculate the average steady-state efficiency for the modulating mode ($\eta_{SS\cdot MOD}$) expressed as a percent and defined as:

$$\eta_{SS\text{-}MOD} = \left[\frac{DHR - Q_{OUT.RED}}{Q_{OUT.MAX} - Q_{OUT.RED}}\right]\left[\frac{T_C - T_{OA^*}}{T_C - 5}\right]\left[\eta_{SS.MAX} - \eta_{SS.ED}\right] + \eta_{SS.RED}$$

where:

DHR = average design heating requirement as listed in Table 1 of this appendix

$Q_{OUT.RED}$ = as defined in 4.5.6 of this appendix

$Q_{OUT.MAX}$ = as defined in 4.5.7 of this appendix

T_C = as defined in 4.5.4 of this appendix and is based on the average design heating requirement listed in Table 3 of this appendix

T_{OA^*} = average outdoor air temperature during the modulating mode, as defined in 4.5.1 of this appendix and is based on the average design heating requirement listed in Table 3 of this appendix

5 = outdoor design temperature, °F

$\eta_{SS.MAX}$ = as defined in 4.5.7 of this appendix

$\eta_{SS.RED}$ = as defined in 4.5.6 of this appendix

4.5.10 *Average on-cycle infiltration heat loss for the modulating mode for furnaces and boilers equipped with step-modulating thermostats.* For furnaces and boilers equipped with step-modulating thermostats, calculate the average on-cycle infiltration heat loss for the modulating mode ($L_{I.ON.MOD}$) expressed as a percent and defined as:

$$L_{I.ON.MOD} = [K_{I.ON.RED}(70 - T_{OA}) + K_{I.ON.MAX}(70 - T_{OA^*})]/2$$

where:

$K_{I.ON.RED}$ = multiplication factor for infiltration loss during burner on-cycle at the reduced firing rate, and defined as $K_{I.ON}$ in 11.2.18 of ANSI/ASHRAE 103–82 at the reduced firing rate

70 = average indoor temperature, °F

T_{OA} = average outdoor temperature in the cycling mode, based on the average design heating requirement, and is listed in either Figure 3 or Table 2 of this appendix

$K_{I.ON.MAX}$ = multiplication factor for infiltration loss during burner on-cycle at the maximum firing rate, and defined as $K_{I.ON}$ in 11.2.18 of ANSI/ASHRAE 103–82 at the maximum firing rate

T_{OA^*} = average outdoor temperature in the modulating mode, based on the average design heating requirement, and is listed in either Figure 3 or Table 3 of this appendix

4.5.11 *Average heat output rate for the modulating mode for furnaces and boilers equipped with step-modulating thermostats.* For furnaces and boilers equipped with step-modulating thermostats, calculate the average heat output rate for the modulating mode ($Q_{OUT.MOD}$) defined as:

$$Q_{OUT.MOD} = [[DHR - Q_{OUT.RED}][T_C - T_{OA^*}]/[T_C - 5]] + Q_{OUT.RED}$$

where:

DHR = average design heating requirement, as listed in Table 1 of this appendix

$Q_{OUT.RED}$ = as defined in 4.5.6 of this appendix

T_C = as defined in 4.5.4 of this appendix and is based on the average design heating requirement listed in Table 3 of this appendix

T_{OA^*} = as defined in 4.5.10 of this appendix and is based on the average design heating requirement listed in Table 3 of this appendix

5 = outdoor design temperature; °F

4.5.12 *Average fuel input rate for the modulating mode for furnaces and boilers equipped with step-modulating thermostats.* For furnaces and boilers equipped with step-modulating thermostats, calculate the average fuel input rate for the modulating mode ($Q_{IN.MOD}$) defined as:

$$Q_{IN.MOD} = Q_{OUT.MOD} / \eta_{SS.MOD}$$

where:

$Q_{OUT.MOD}$ = as defined in 4.5.11 of this appendix

$\eta_{SS.MOD}$ = as defined in 4.5.9 of this appendix

4.5.13 *Average outdoor temperature.* For furnaces and boilers equipped with two stage thermostats or with step-modulating thermostats operating at the reduced operating mode, the average outdoor temperature shall be T_{OA}, as obtained either from Figure 3 or Table 3 of this appendix. For furnaces and boilers equipped with two stage thermostats operating at the maximum operating mode or with step-modulating thermostats operating at the modulating mode, the average outdoor temperature shall be T_{OA^*}, as obtained from either Figure 3 or Table 3 of this appendix. These values for the average outdoor temperature shall replace the value of 42 specified as the average outdoor temperature in sections 11.2.15, 11.2.17, 11.2.19, 11.2.30, 11.2.31, and 11.2.33 of ANSI/ASHRAE 103–82.

4.5.14 *Weighted-average steady-state efficiency.* For furnaces and boilers equipped with two stage thermostats, calculate the weighted-average steady-state efficiency ($\eta_{SS.WT}$) expressed as a percent and defined as:

$$\eta_{SS.WT} = X_2 \eta_{SS.MAX} + X_1 \eta_{SS.RED}$$

where:

X_1 = as defined in 4.5.2 of this appendix

$\eta_{SS.MAX}$ = as defined in 4.5.7 of this appendix

X_2 = as defined in 4.5.3 of this appendix

$\eta_{SS.RED}$ = as defined in 4.5.6 of this appendix

For furnaces and boilers equipped with step-modulating thermostats, calculate $\eta_{SS.WT}$ defined as:

$$\eta_{SS.WT} = X_2 \eta_{SS.MOD} + X_1 \eta_{SS.RED}$$

where:

X_1 = as defined in 4.5.2 of this appendix

$\eta_{SS.MOD}$ = as defined in 4.5.9 of this appendix

X_2 = as defined in 4.5.3 of this appendix

$\eta_{SS.RED}$ = as defined in 4.5.6 of this appendix

4.6 *Annual fuel utilization efficiency.* The annual fuel utilization efficiency (AFUE) shall be expressed as a percent and defined as:

$$AFUE = \frac{5200 \eta_{SS} \eta_U Q_{IN}}{5200 \eta_{SS} Q_{IN} + 2.5(1 + 0.7)(4600) \eta_U Q_P}$$

where:

5200 = average annual heating degree-days

η_{SS} as defined in 4.3 of this appendix for condensing furnaces and boilers measured by the optional direct condensate measurement method; as

$\eta_{SS\text{-}WT}$ as defined in 4.5.14 of this appendix at each design heating requirement for modulating furnaces and boilers; or as $Effy_{SS}$ as defined in 11.2.5 of ANSI/ASHRAE 103–82 for all other furnaces and boilers

η_U=as defined in 4.3 of this appendix for condensing furnaces and boilers measured by the optional direct condensate measurement method: as $\eta_{U\text{-}WT}$ as defined in 4.5.1 of this appendix at each design heating requirement for modulating furnaces and boilers; or as $Effy_{hs}$ as defined in 11.2.34 of ANSI/ASHRAE 103–82 and in 4.2 of this appendix for all other furnaces and boilers except that C_j and L_j are defined as:

C_j =
- 0 for furnaces or boilers intended to be installed indoors
- 3.3 for furnaces intended to be installed outdoors
- 1.7 for furnaces intended to be installed as isolated combustion systems
- 4.7 for boilers intended to be installed outdoors
- 2.4 for boilers intended to be installed as isolated combustion systems

L_j=jacket loss and is either assigned the value of 1 percent or determined in accordance with 8.6 of ANSI/ASHRAE 103–82 in percent

Q_{IN}=steady-state heat input as defined in 11.2.34 of ANSI/ASHHRAE 103–82

0.7=average oversizing factor for furnaces and boilers

4600=average non-heating season hours per year

Q_P=pilot flame fuel input rate as defined in 9.2 of ANSI/ASHRAE 103–82

4.7 *National average number of burner operating hours.* For furnaces and boilers equipped with single stage thermostats, calculate the national average number of burner operating hours (BOH_{SS}) defined as:

BOH_{SS}=2080(0.77)A DHR–2080 B

where:

2080=national average heating load hours

0.77=adjustment factor which serves to adjust the calculated design heating requirement and heating load hours to the actual heating load experienced by a heating system

DHR=typical design heating requirements, as listed in Table 1 of this appendix using the proper value of Q_{OUT} where:

$Q_{OUT}=(\eta_{SS}/100-(K)(L_j)/100)(Q_{IN})$ rounded off to the nearest 1,000 Btu/hr

where:

η_{SS} as defined in 4.3 of this appendix for condensing furnaces and boilers measured by the optional direct condensate measurement method: as $\eta_{SS\text{-}WT}$ as defined in 4.5.14 of this appendix at each design heating requirement for modulating furnaces and boilers; or as $Effy_{SS}$ as defined in 11.2.5 of ANSI/ASHRAE 103–82 for all other furnaces and boilers.

Q_{IN} as defined in 11.2.34 of ANSI/ASHRAE 103–82

K=factor that adjusts jacket losses measured in the laboratory to those that would be measured under outdoor design conditions.

0 for furnaces or boilers intended to be installed indoors.

1.7 for furnaces or boilers intended to be installed as isolated combustion systems.

3.3 for furnaces or boilers intended to be installed outdoors.

1.0 for finned tubed boilers intended for installation outdoors.

L_J=jacket loss

$A=100{,}000/[341{,}300(PE+y\ BE)+(Q_{IN}-Q_P)\eta_U]$

$B=2\ Q_P\eta_U A/100{,}000$

100,000=factor that accounts for percent and kBtu

PE=power burner electrical energy input rate at full-load steady-state operation, as defined in 9.1 of ANSI/ASHRAE 103–82

y=
- ratio of average blower or pump on time to average burner on time
- 1. for furnaces without a fan delay
- 1. for boilers without a pump delay
- $1+(t^+-t^-)/3.87$, for single stage furnaces with fan delay
- $1+(t^+-t^-)/10.00$, for two stage and step modulating furnaces with fan delay
- $1+(t^+/9.68)$, for single stage boilers with pump delay
- $1+(t^+/15.00)$, for two stage and step modulating boilers with pump delay

BE=circulating air fan (or circulating water pump) electrical energy input rate at full-load steady-state operation, as defined in 9.1 of ANSI/ASHRAE 103–82

Q_{IN}=as defined in 11.2.34 of ANSI/ASHRAE 103–82

Q_P=as defined in 11.2.34 of ANSI/ASHRAE 103–82

$\eta\mu$=as defined in 4.6 of this appendix

2=ratio of the average length of a heating season in hours to the average heating load hours

t^+=as defined in 3.3 of this appendix

t^-=as defined in 9.3.1 of ANSI/ASHRAE 103–82

For furnaces and boilers equipped with two stage thermostats or step-modulating thermostats, calculate the national average number of burner operating hours at the reduced operating mode (BOH_{RED}) defined as:

$BOH_{RED}=X_1\ E_M/Q_{IN\text{-}RED}$

where:

X^1=as defined in 4.5.2 of this appendix

E_M=average annual energy used during the heating season

$E_M=(Q_{IN\text{-}MAX}-Q_P)BOH_{SS}+(8760-4600)Q_P$

$Q_{IN\text{-}RED}$=as defined in 4.5.6 of this appendix

$Q_{IN\text{-}MAX}$=as defined in 4.5.7 of this appendix

Q_P=as defined in 11.2.34 of ANSI/ASHRAE 103–82

BOH_{SS}=as defined in 4.7 of this appendix in which $\eta_{U\text{-}WT}$ replaces η_U for calculating the values of A and B and the term (PE + y BE) in the factor A is increased by the ratio, R. It is defined as:

R=
- 2.3 for two stage controls
- 2.3 for step-modulating controls when the ratio of minimum-to-maximum output is greater than or equal to 0.5
- 3.0 for step modulating controls when the ratio of minimum-to-maximum out is less than 0.5

$A=100{,}000/[341{,}300(PE+y\ BE)R+(Q_{IN}-Q_P)\eta_U]$

8760=total number of hours per year

4600=as defined in 4.6 of this appendix

For furnaces and boilers equipped with two stage thermostats, calculate the national average number of burner operating hours at the maximum operating mode (BOH_{MAX}) defined as:

$BOH_{MAX}=X_2E_M/Q_{IN\text{-}MAX}$

where:

X_2=as defined in 4.5.3 of this appendix

E_M=as defined in 4.7 of this appendix

$Q_{IN\text{-}MAX}$=as defined in 4.5.7 of this appendix

For furnaces and boilers equipped with step-modulating thermostats, calculate the national average number of burner operating hours in the modulating mode (BOH_{MOD}) defined as:

$BOH_{MOD}=X_2E_M/Q_{IN\text{-}MOD}$

where:

X_2=as defined in 4.5.3 of this appendix

E_M=as defined in 4.7 of this appendix

$Q_{IN\text{-}MOD}$=as defined in 4.5.12 of this appendix

4.8 *Average annual fuel energy consumption for gas or oil fueled furnaces or boilers.* For furnaces and boilers equipped with single stage thermostats, calculate the average annual fuel energy consumption for gas or oil fueled furnaces or boilers (E_F) expressed in Btu's per year and defined as:

$E_F=BOH(Q_{IN}-Q_P)+8760\ Q_P$

where:

BOH=as defined in 4.7 of this appendix

Q_{IN}=as defined in 11.2.34 of ANSI/ASHRAE 103–82

Q_P=as defined in 11.2.34 of ANSI/ASHRAE 103–82

8760=as defined in 4.7 of this appendix

For furnaces and boilers equipped with either two stage thermostats or step-modulating thermostats, calculate E_F as defined as:

$E_F=E_M+4600\ Q_P$

where:

E_M=as defined in 4.7 of this appendix

4600=as defined in 4.6 of this appendix

Q_P=as defined in 11.2.34 of ANSI/ASHRAE 103–82

4.9 *Average annual auxiliary electrical energy consumption for gas or oil fueled furnaces or boilers.* For furnaces and boilers equipped with single stage thermostats, calculate the average annual auxiliary electrical energy consumption (E_{AE}) expressed in kilowatt-hours per year and defined as:

$E_{AE} = BOH_{SS}\ (PE + y\ BE)$

where:

BOH_{SS} = as defined in 4.7 of this appendix
PE = as defined in 9.1 of ANSI/ASHRAE 103–82
y = as defined in 4.7 of this appendix
BE = as defined in 9.1 of ANSI/ASHRAE 103–82

For furnaces and boilers equipped with two stage thermostats, calculate E_{AE} defined as:

$E_{AE} = BOH_{RED}\ (PE_{RED} + y\ BE_{RED}) + BOH_{MAX}(PE_{MAX} + y\ BE_{MAX})$

where:

BOH_{RED} = as defined in 4.7 of this appendix
PE_{RED} = as defined in 9.1 of ANSI/ASHRAE 103–82, measured at the reduced fuel input rate
y = as defined in 4.7 of this appendix
BE_{RED} = as defined in 9.1 of ANSI/ASHRAE 103–82, measured at the reduced fuel input rate
BOH_{MAX} = as defined in 4.7 of this appendix
PE_{MAX} = as defined in 9.1 of ANSI/ASHRAE 103–82, measured at the maximum fuel input rate
BE_{MAX} = as defined in 9.1 of ANSI/ASHRAE 103–82, measured at the maximum fuel input rate

For furnaces and boilers equipped with step-modulating thermostats, calculate E_{AE} defined as:

$E_{AE} = BOH_{RED}\ (PE_{RED} + y\ BE_{RED}) + BOH_{MOD}(PE_{MAX} + y\ BE_{MAX})$

where:

BOH_{RED} = as defined in 4.7 of this appendix
PE_{RED} = as defined in 4.9 of this appendix
y = as defined in 4.7 of this appendix
BE_{RED} = as defined in 4.9 of this appendix
BOH_{MOD} = as defined in 4.7 of this appendix
PE_{MAX} = as defined in 4.9 of this appendix
BE_{MAX} = as defined in 4.9 of this appendix

4.10 *Average annual electric energy consumption for electric furnaces or boilers.* For electric furnaces and boilers, calculate the average annual electric energy consumption (E_E) expressed in kilowatt-hours per year and defined as:

$E_E = 100(2080)(0.77)\ DHR/3.412\ AFUE$

where:

100 = conversion to express a percent as a decimal
2080 = as defined in 4.7 of this appendix
0.77 = as defined in 4.7 of this appendix
DHR = as defined in 4.7 of this appendix
3.412 = conversion to express energy in terms of watt-hours instead of Btu
AFUE = as defined in 4.1 of this appendix

4.11 *Average annual fuel energy consumption for gas or oil fueled furnaces or boilers located in different geographic regions of the United States and in buildings with different design heating requirements.* For gas or oil fueled furnaces and boilers, calculate the average annual fuel energy consumption for a specific geographic region and for a specific typical design heating requirement (E_{FR}) expressed in Btu's per year and defined as:

$E_{FR} = [(E_F - 8760\ Q_P)HLH/2080] + 8760\ Q_P$

where:

E_F = as defined in 4.8 of this appendix
8760 = as defined in 4.7 of this appendix
Q_P = as defined in 11.2.34 of ANSI/ASHRAE 103–82
HLH = heating load hours for a specific geographic region determined in accordance with the heating load hour map in Figure 1 of this appendix
2080 = as defined in 4.7 of this appendix

4.12 *Average annual auxiliary electrical energy consumption for gas or oil fueled furnaces or boilers located in different geographic regions of the United States and in buildings with different design heating requirements.* For gas or oil fueled furnaces and boilers, calculate the average annual auxiliary electrical energy consumption for a specific geographic region and for a specific typical design heating requirement (E_{AER}) expressed in kilowatt-hours per year and defined as:

$E_{AER} = E_{AE}HLH/2080$

where:

E_{AE} = as defined in 4.9 of this appendix
HLH = as defined in 4.11 of this appendix
2080 = as defined in 4.7 of this appendix

4.13 *Average annual electric energy consumption for electric furnaces or boilers located in different geographic regions of the United States and in buildings with different design heating requirements.* For electric furnaces and boilers, calculate the average annual electric energy consumption for a specific geographic region and for a specific typical design heating requirement (E_{ER}) expressed in kilowatt-hours per year and defined as:

$E_{ER} = 100(0.77)DHR\ HLH/3.412\ AFUE$

where:

100 = as defined in 4.10 of this appendix
0.77 = as defined in 4.7 of this appendix
DHR = as defined in 4.7 of this appendix
HLH = as defined in 4.11 of this appendix
3.412 = as defined in 4.10 of this appendix
AFUE = as defined in 4.1 of this appendix

4.14 *Energy factor.* For electric furnaces and boilers, the energy factor (EF) is equal to AFUE, as defined in section 4.1 of this appendix. For gas and oil furnaces and boilers, calculate EF as defined as:

$EF = \eta_U[E_F - 4600\ Q_P]/[E_F + 3412\ E_{AE}]$

where:

η_U = as defined in 4.6 of this appendix
E_F = as defined in 4.8 of this appendix
4600 = as defined in 4.6 of this appendix
Q_P = as defined in 11.2.34 of ANSI/ASHRAE 103–82
3142 = as defined in 4.10 of this appendix
E_{AE} = as defined in 4.9 of this appendix

TABLE 1.—AVERAGE AND TYPICAL DESIGN HEATING REQUIREMENTS FOR FURNACES AND BOILERS WITH DIFFERENT OUTPUT CAPACITIES

Furnace or boiler output capacity, Q_{out} (Btu/hr)	Average design heating requirements (KBtu/hr)	Typical design heating requirements (KBtu/hr)
5,000–10,000	5	5
11,000–16,000	10	5, 10
17,000–25,000	15	10, 15
26,000–34,000	20	15, 20
35,000–42,000	25	20, 25, 30
43,000–51,000	30	25, 30, 35
52,000–59,000	35	30, 35, 40, 45
60,000–76,000	40	35, 40, 45, 50
77,000–93,000	50	40, 45, 50, 60
94,000–110,000	60	50, 60, 70, 80
111,000–127,000	70	60, 70, 80, 90
128,000–144,000	80	70, 80, 90, 100
145,000–161,000	90	80, 90, 100, 110, 120
162,000–178,000	100	90, 100, 110, 120, 130
179,000–195,000	110	100, 110, 120, 130, 140
over 196,000	130	120, 130, 140, 150, 160

TABLE 2.—AVERAGE BURNER ON-TIME AND OFF-TIME PER CYCLE FOR FURNACES AND BOILERS (MINUTES)

Thermostat type	Furnaces		Boilers	
	t_{on}	t_{off}	t_{on}	t_{off}
Single stage	3.87	13.3	9.68	33.26
Two stage	10.0	10.0	15.0	15.0
Step modulating	10.0	10.0	15.0	15.0

TABLE 3.—FRACTIONAL HEATING LOADS AND AVERAGE OUTDOOR TEMPERATURES FOR FURNACES AND BOILERS EQUIPPED WITH MODULATING CONTROLS

Balance point temperature range (°F)	Fractional heating load		Average outdoor temperature (°F)	
	Reduced rate	Modulating or maximum rate	Reduced rate	Modulating or maximum rate
(T_C)	(X_1)	(X_2)	(T_{OA})	(T_{OA}^*)
6 to 15	0.95	0.05	41	9
16 to 20	0.90	0.10	42	14
21 to 25	0.84	0.16	43	18
26 to 28	0.77	0.23	44	22
29 to 31	0.70	0.30	45	24
32 to 33	0.66	0.34	46	26
34 to 35	0.60	0.40	47	27
36 to 37	0.54	0.46	48	28
38 to 39	0.48	0.52	48	30
40 to 41	0.42	0.58	49	31
42 to 43	0.35	0.65	50	32
44 to 45	0.29	0.71	51	33
46 to 47	0.23	0.77	52	35
48 to 49	0.18	0.82	54	36
50 to 52	0.12	0.88	55	37
53 to 57	0.07	0.93	58	39
58 to 62	0.02	0.98	61	40

NOTE.—This table is based on national average 5,200 degree-days.

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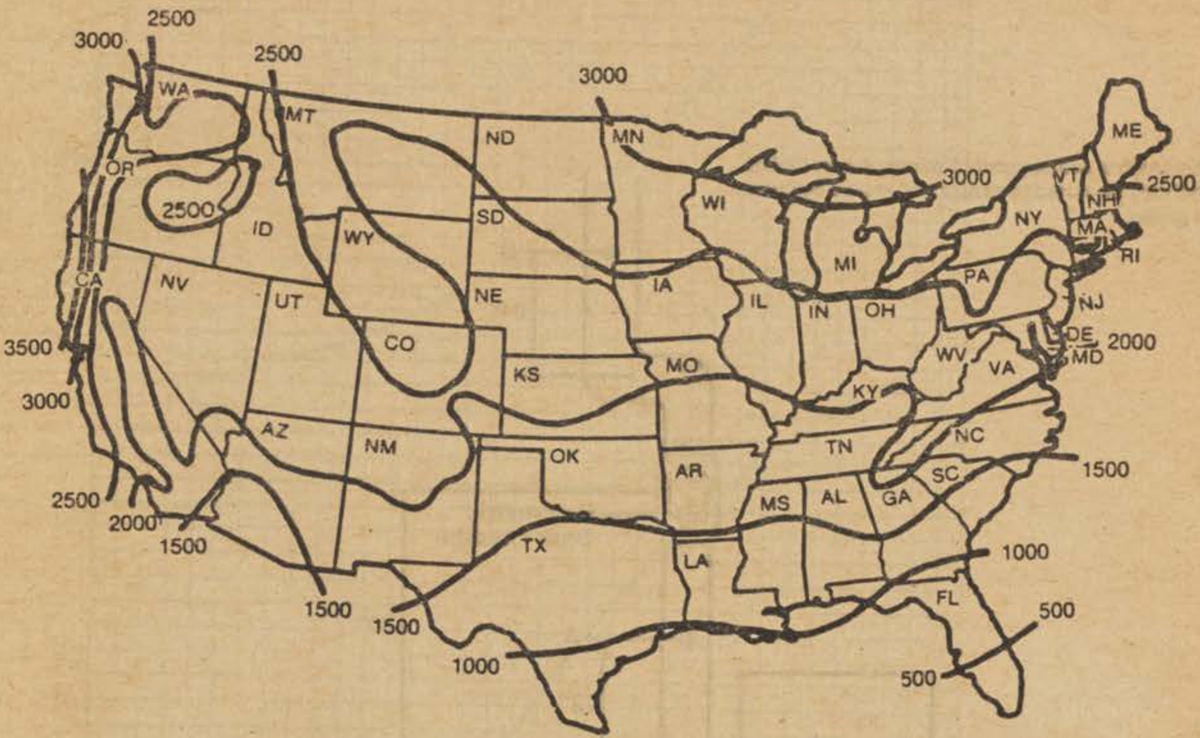
FIGURE I

Heating Load Hours (HLH) for the United States and Territories



This map is reasonably accurate for most parts of the United States but is necessarily highly generalized and consequently not too accurate in mountainous regions, particularly in the Rockies.

Alaska	— 3500 HLH
Hawaii and Territories	— O HLH

FIGURE 2

Test Setup for Measuring S/F for Furnaces and Boilers with Barometric Draft Controls

Note: Dimensions are suggested minimums in inches and may be varied to assure well-mixed samples of gases.

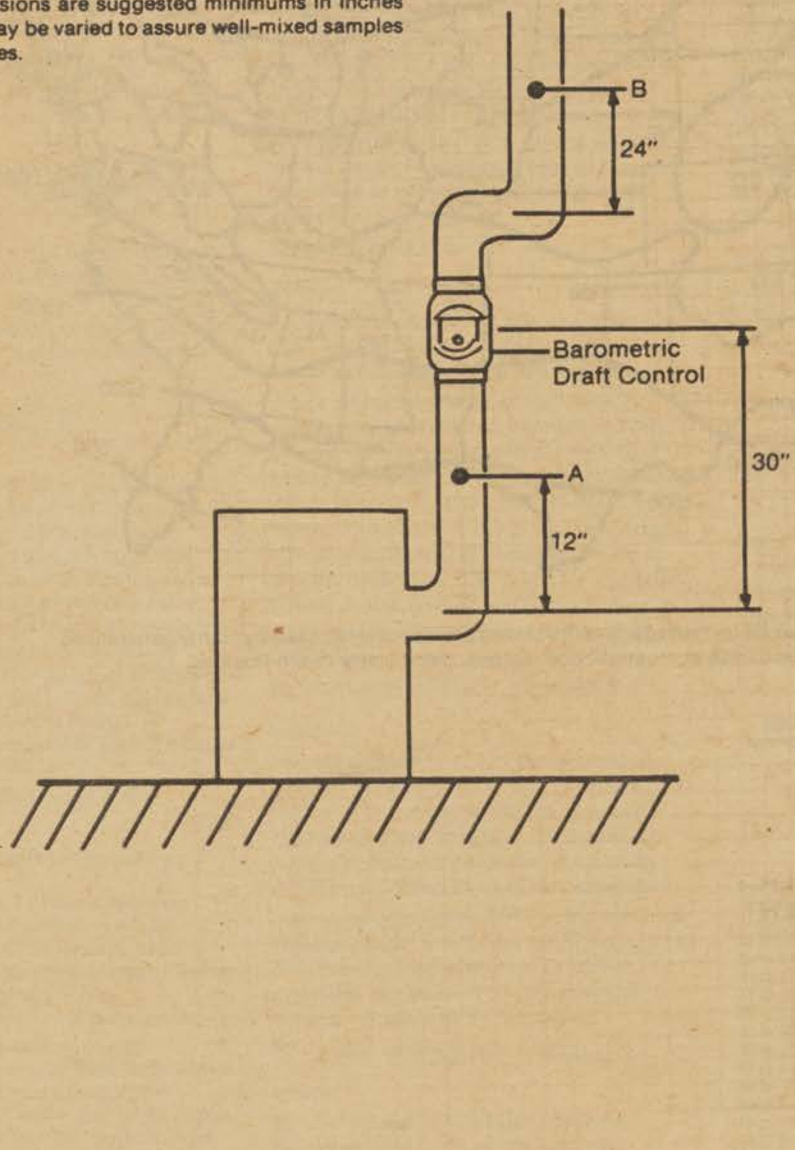
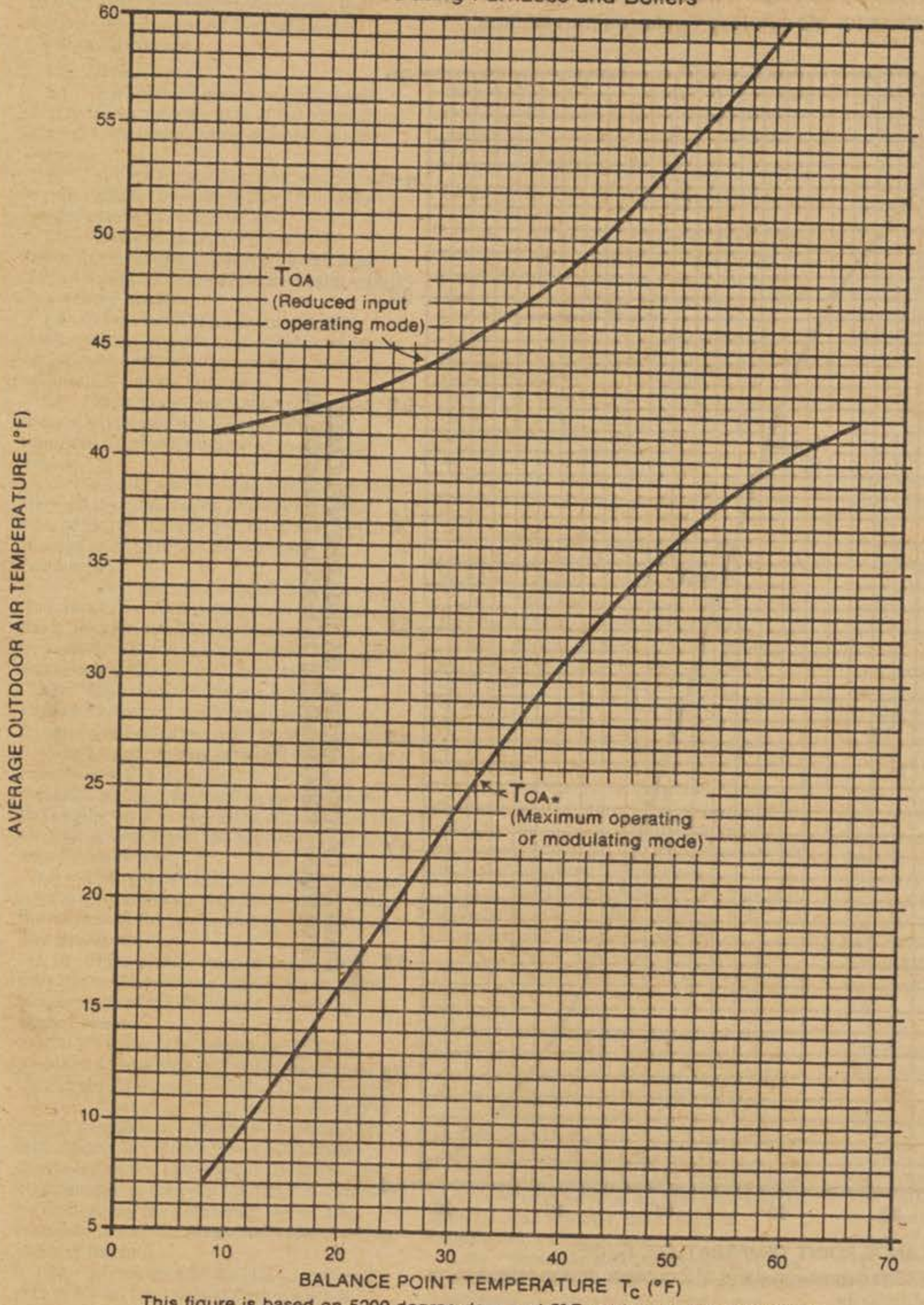


FIGURE 3

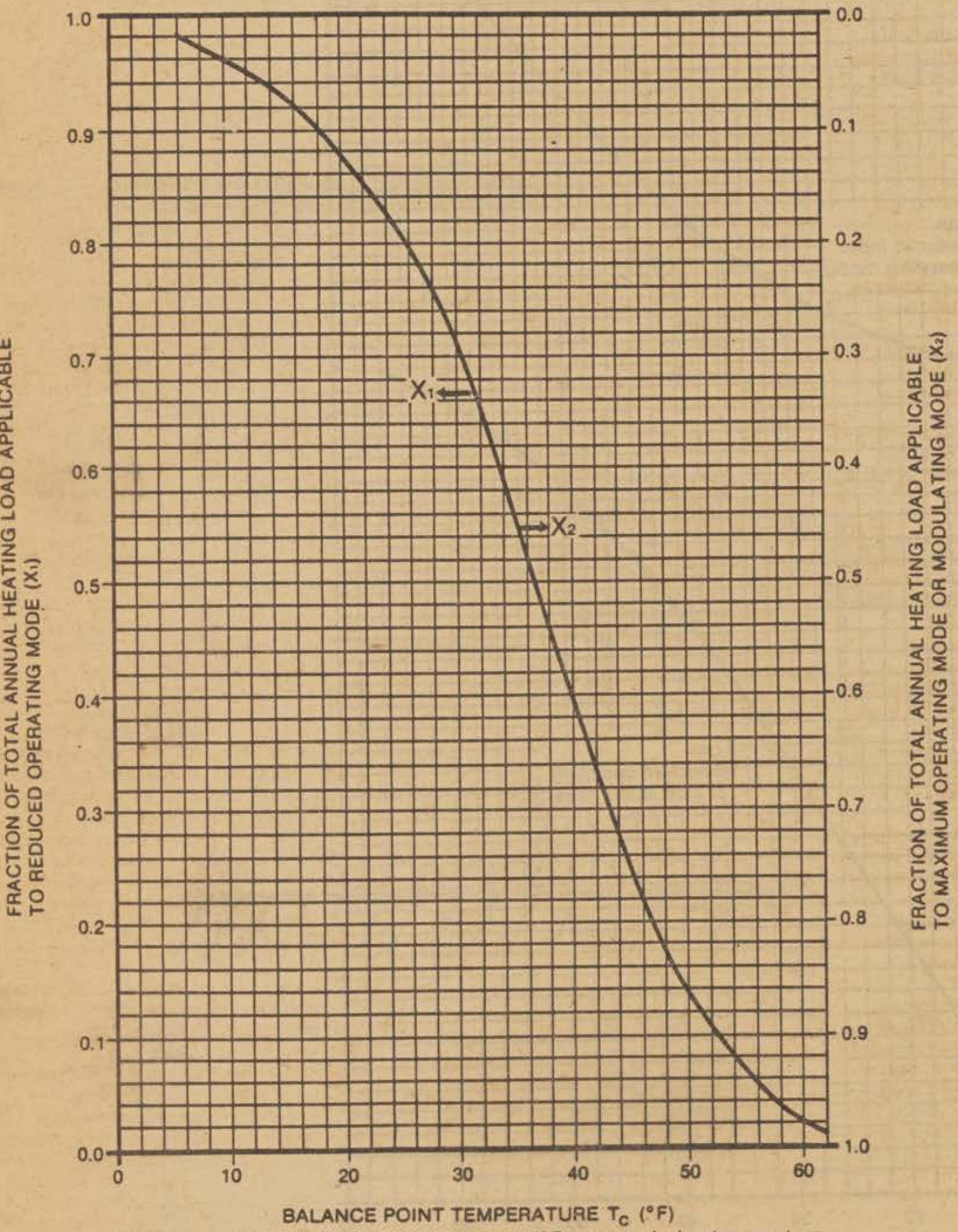
Average Outdoor Air Temperature vs. Balance Point Temperature for Modulating Furnaces and Boilers



This figure is based on 5200 degree-days and 5°F outdoor design temperature.

FIGURE 4

Fraction of Total Annual Heating Load Applicable to Reduced Operating Mode (X_1) and to Maximum Operating Mode or Modulating Mode (X_2) vs. Balance Point Temperature for Modulating Furnaces and Boilers.



This figure is based on 5200 degree-days and 5°F outdoor design temperature.

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5. Appendix O to Subpart B of Part 430 is revised to read as follows:

Appendix O to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Vented Home Heating Equipment

1.0 *Definitions.*

1.1 "Air shutter" means an adjustable device for varying the size of the primary air inlet(s) to the combustion chamber power burner.

1.2 "Air tube" means a tube which carries combustion air from the burner fan to the burner nozzle for combustion.

1.3 "Barometic draft regulator or barometric damper" means a mechanical device designed to maintain a constant draft in a vented heater.

1.4 "Draft hood" means an external device which performs the same function as an integral draft diverter, as defined in section 1.17 of this appendix.

1.5 "Electro-mechanical stack damper" means a type of stack damper which is operated by electrical and/or mechanical means.

1.6 "Excess air" means air which passes through the combustion chamber and the vented heater flues in excess of that which is theoretically required for complete combustion.

1.7 "Flue" means a conduit between the flue outlet of a vented heater and the integral draft diverter, draft hood, barometric damper or vent/terminal through which the flue gases pass prior to the point of draft relief.

1.8 "Flue damper" means a device installed between the furnace and the integral draft diverter, draft hood, barometric draft regulator, or vent terminal which is not equipped with a draft control device, designed to open the venting system when the appliance is in operation and to close the venting system when the appliance is in a standby condition.

1.9 "Flue gases" means reaction products resulting from the combustion of a fuel with the oxygen of the air, including the inerts and any excess air.

1.10 "Flue losses" means the sum of sensible and latent heat losses above room temperature of the flue gases leaving a vented heater.

1.11 "Flue outlet" means the opening provided in a vented heater for the exhaust of the flue gases from the combustion chamber.

1.12 "Heat input" (Q_{in}) means the rate of energy supplied in a fuel to a vented heater operating under steady-state conditions, expressed in Btu's per hour. It includes any input energy to the pilot light and is obtained by multiplying the measured rate of fuel consumption by the measured higher heating value of the fuel.

1.13 "Heating capacity" (Q_{out}) means the rate of useful heat output from a vented heater, operating under steady-state conditions, expressed in Btu's per hour. For room and wall heaters, it is obtained by multiplying the "heat input" (Q_{in}) by the steady-state efficency (η_{ss}) divided by 100. For floor furnaces, it is obtained by multiplying (A) the "heat input" (Q_{in}) by (B) the steady-state efficiency divided by 100, minus the quantity (2.8) (L_j) divided by 100, where L_j is the jacket loss as determined in section 3.2 of this appendix.

1.14 "Higher heating value" (HHV) means the heat produced per unit of fuel when complete combustion takes place at constant pressure and the products of combustion are cooled to the initial temperature of the fuel and air and when the water vapor formed during combustion is condensed. The higher heating value is usually expressed in Btu's per pound, Btu's per cubic foot for gaseous fuel, or Btu's per gallon for liquid fuel.

1.15 "Induced draft" means a method of drawing air into the combustion chamber by mechanical means.

1.16 "Infiltration parameter" means that portion of unconditioned outside air drawn into the heated space as a consequence of loss of conditioned air through the exhaust system of a vented heater.

1.17 "Integral draft diverter" means a device which is an integral part of a vented heater, designed to: (1) Provide for the exhaust of the products of combustion in the event of no draft, back draft, or stoppage beyond the draft diverter, (2) prevent a back draft from entering the vented heater, and (3) neutralize the stack action of the chimney or gas vent upon the operation of the vented heater.

1.18 "Manually controlled vented heaters" means either gas or oil fueled vented heaters equipped without thermostats.

1.19 "Modulating control" means either a step-modulating or two-stage control.

1.20 "Power burner" means a vented heater burner which supplies air for combustion at a pressure exceeding atmospheric pressure, or a burner which depends on the draft induced by a fan incorporated in the furnace for proper operation.

1.21 "Reduced heat input rate" means the factory adjusted lowest reduced heat input rate for vented home heating equipment equipped with either two stage thermostats or step-modulating thermostats.

1.22 "Single stage thermostat" means a thermostat that cycles a burner at the maximum heat input rate and off.

1.23 "Stack" means the portion of the exhaust system downstream of the integral draft diverter, draft hood or barometric draft regulator.

1.24 "Stack damper" means a device installed downstream of the integral draft diverter, draft hood, or barometric draft regulator, designed to open the venting system when the appliance is in operation and to close off the venting system when the appliance is in the standby condition.

1.25 "Stack gases" means the flue gases combined with dilution air that enters at the integral draft diverter, draft hood or barometric draft regulator.

1.26 "Steady-state conditions for vented home heating equipment" means equilibrium conditions as indicated by temperature variations of not more than 5° F (2.8C) in the flue gas temperature for units equipped with draft hoods, barometric draft regulators or direct vent systems, in three successive readings taken 15 minutes apart or not more than 3° F (1.7C) in the stack gas temperature for units equipped with integral draft diverters in three successive readings taken 15 minutes apart.

1.27 "Step-modulating control" means a control that either cycles off and on at the low input if the heating load is light, or gradually, increases the heat input to meet any higher heating load that cannot be met with the low firing rate.

1.28 "Thermal stack damper" means a type of stack damper which is dependent for operation exclusively upon the direct conversion of thermal energy of the stack gases into movement of the damper plate.

1.29 "Two stage control" means a control that either cycles a burner at the reduced heat input rate and off or cycles a burner at the maximum heat input rate and off.

1.30 "Vaporizing-type oil burner" means a device with an oil vaporizing bowl or other receptacle designed to operate by vaporizing liquid fuel oil by the heat of combustion and mixing the vaporized fuel with air.

1.31 "Vent/air intake terminal" means a device which is located on the outside of a building and is connected to a vented heater by a system of conduits. It is composed of an air intake terminal through which the air for combustion is taken from the outside atmosphere and a vent terminal from which flue gases are discharged.

1.32 "Vent limiter" means a device which limits the flow of air from the atmospheric diaphragm chamber of a gas pressure regulator to the atmosphere. A vent limiter may be a limiting orifice or other limiting device.

1.33 "Vent pipe" means the passages and conduits in a direct vent system through which gases pass from the combustion chamber to the outdoor air.

2.0 *Testing conditions.*

2.1 *Installation of test unit.*

2.1.1 *Vented wall furnaces (including direct vent systems).* Install gas fueled vented wall furnaces for test as specified in sections 2.1.3 and 2.1.4 of ANSI Z21.49–1975. Install gas fueled wall furnaces with direct vent systems for test as described in sections 2.1.3 and 2.1.4 of ANSI Z21.44–1973. Install oil fueled vented wall furnaces as specified in UL–730–1974, section 33. Install oil fueled vented wall furnaces with direct vent systems as specified in UL–730–1974, section 34.

2.1.2 *Vented floor furnaces.* Install vented floor furnaces for test as specified in sections 35.1 through 35.5 of UL–729–1976.

2.1.3 *Vented room heaters.* Install in accordance with manufacturer's instructions.

2.2 *Flue and stack requirements.*

2.2.1 *Gas fueled vented home heating equipment employing integral draft diverters and draft hoods (excluding direct vent systems).* Attach to, and vertically above the outlet of gas fueled vented home heating equipment employing draft diverters or draft hoods with vertically discharging outlets, a five (5) foot long test stack having a cross sectional area the same size as the draft diverter outlet.

Attach to the outlet of vented heaters having a horizontally discharging draft diverter or draft hood outlet a 90 degree elbow, and a five (5) foot long vertical test stack. A horizontal section of pipe may be used on the floor furnace between the diverter and the elbow if necessary to clear any framing used in the installation. Use the minimum length of pipe possible for this section. Use stack, elbow, and horizontal section with same cross sectional area as the diverter outlet.

2.2.2 *Oil fueled vented home heating equipment (excluding direct vent systems).* Use flue connections for oil fueled vented floor furnaces as specified in section 35 of UL 729–1976, sections 34.10 through 34.18 of UL 730–1974 for oil fueled vented wall furnaces and sections 36.2 and 36.3 of UL 896–1973 for oil fueled vented room heaters.

2.2.3 *Direct vent systems.* Have the exhaust/air intake system supplied by the manufacturer in place during all tests. Test units intended for installation with a variety of vent pipe lengths with the minimum length recommended by the manufacturer. Do not connect a heater employing a direct vent system to a chimney or induced draft source. Vent the gas solely on the provision for venting incorporated in the heater and the vent/air intake system supplied with it.

2.3 *Fuel supply.*

2.3.1 *Natural gas.* For a vented heater utilizing natural gas, maintain the gas supply to the unit under test at a normal inlet test pressure immediately ahead of all controls at 7 to 10 inches water column. Maintain the regulator outlet pressure at normal test pressure approximately at that recommended by the manufacturer. Use natural gas having a specific gravity of approximately 0.65 and a higher heating value within ± 5 percent of 1,025 Btu's per standard cubic foot. Determine the actual higher heating value in Btu's per standard cubic foot for the natural gas to be used in the test with an error no greater than one percent.

2.3.2 *Propane gas.* For a vented heater utilizing propane gas, maintain the gas supply to the unit under test at a normal inlet pressure of 11 to 13 inches water column and a specific gravity of approximately 1.53. Maintain the regulator outlet pressure, on units so equipped, approximately at that recommended by the manufacturer. Use propane having a specific gravity of approximately 1.53 and a higher heating value within ± 5 percent of 2,500 Btu's per standard cubic foot. Determine the actual higher heating value in Btu's per standard cubic foot for the propane to be used in the test with an error no greater than one percent.

2.3.3 *Other test gas.* Use other test gases with characteristics as described in section 2.2, table VII, of ANSI Standard Z21.11.1–1974. Use gases with a measured higher heating value within ± 5 percent of the values specified in the above ANSI standard. Determine the actual higher heating value of the gas used in the test with an error no greater than one percent.

2.3.4 *Oil supply.* For a vented heater utilizing fuel oil, use No. 1, fuel oil (kerosene) for vaporizing-type burners and either No. 1 or No. 2 fuel oil, as specified by the manufacturer, for mechanical atomizing type burners. Use No. 1 fuel oil with a viscosity meeting the specifications as specified in UL–730–1974, section 36.9. Use test fuel conforming to the specifications given in tables 2 and 3 of ANSI Standard Z91.1–1972 for No. 1 and No. 2 fuel oil. Measure the higher heating value of the test fuel with an error no greater than one percent.

2.3.5 *Electrical supply.* For auxiliary electric components of a vented heater, maintain the electrical supply to the test unit within one percent of the nameplate voltage for the entire test cycle. If a voltage range is used for nameplate voltage, maintain the electrical supply within one percent of the mid-point of the nameplate voltage range.

2.4 *Burner adjustments.*

2.4.1 *Gas burner adjustments.* Adjust the burners of gas fueled vented heaters to their maximum Btu ratings at the test pressure specified in section 2.3 of this appendix. Correct the burner volumetric flow rate to 60° F (15.6C) and 30 inches of mercury barometric pressure, set the fuel flow rate to obtain a heat rate of within ±2 percent of the hourly Btu rating specified by the manufacturer as measured after 15 minutes of operation starting with all parts of the vented heater at room temperature. Set the primary air shutters in accordance with the manufacturer's recommendations to give a good flame at this adjustment. Do not allow the deposit of carbon during any test specified herein.

If a vent limiting means is provided on a gas pressure regulator, have it in place during all tests.

For gas fueled heaters with modulating controls adjust the controls to operate the heater at the maximum fuel input rate. Set the thermostat control to the maximum setting. Start the heater by turning the safety control valve to the "on" position. In order to prevent modulation of the burner at maximum input, place the thermostat sensing element in a temperature control bath which is held at a temperature below the maximum set point temperature of the control.

For gas fueled heaters with modulating controls adjust the controls to operate the heater at the reduced fuel input rate. Set the thermostat control to the minimum setting. Start the heater by turning the safety control valve to the "on" position. If ambient test room temperature is above the lowest control set point temperature, initiate burner operation by placing the thermostat sensing element in a temperature control bath that is held at a temperature below the minimum set point temperature of the control.

2.4.2 *Oil burner adjustments.* Adjust the burners of oil fueled vented heaters to give the CO_2 reading recommended by the manufacturer and an hourly Btu input, during the steady-state performance test described below, which is within ±2 percent of the heater manufacturer's specified normal hourly Btu input rating. On units employing a power burner do not allow smoke in the flue to exceed a No. 1 smoke during the steady-state performance test as measured by the procedure in ANSI Standard Z11.182–1965 (R1971) (ASTM D 2156–65 (1970)). If, on units employing a power burner, the smoke in the flue exceeds a No. 1 smoke during the steady-state test, readjust the burner to give a lower smoke reading, and, if necessary a lower CO_2 reading, and start all tests over. Maintain the avérage draft over the fire and in the flue during the steady-state performance test at that recommended by the manufacturer within ±0.005 inches of water gauge. Do not make additional adjustments to the burner during the required series of performance tests. The instruments and measuring apparatus for this test are described in section 6.3 of ANSI standard Z91.1–1972.

2.5 *Circulating air adjustments.*

2.5.1 *Forced air vented wall furnaces (including direct vent systems).* During tests maintain the air flow through the heater as specified by the manufacturer and operate the vented heater with the outlet air temperature between 80° F and 130° F above room temperature. If adjustable air discharge registers are provided, adjust them so as to provide the maximum possible air restriction. Measure air discharge temperature as specified in section 2.14 of ANSI Z21.49–1975.

2.5.2 *Fan type vented room heaters and floor furnaces.* During tests on fan type furnaces and heaters, adjust the air flow through the heater as specified by the manufacturer. If adjustable air discharge registers are provided, adjust them to provide the maximum possible air restriction.

2.6 *Location of temperature measuring instrumentation.*

2.6.1 *Gas fueled vented home heating equipment (including direct vent systems).* For units employing an integral draft diverter, install nine thermocouples, wired in parallel, in a horizontal plane in the five foot test stack located one foot from the test stack inlet. Equalize the length of all thermocouple leads before paralleling. Locate one thermocouple in the center of the stack. Locate eight thermocouples along imaginary lines intersecting at right angles in this horizontal plane at points one third and two thirds of the distance between the center of the stack and the stack wall.

For units which employ a direct vent system, locate at least one thermocouple at the center of each flue way exiting the heat exchanger. Provide radiation shields if the thermocouples are exposed to burner radiation.

For units which employ a draft hood or units which employ a direct vent system which does not significantly preheat the incoming combustion air, install nine thermocouples, wired in parallel, in a horizontal plane located within 12 inches (304.8 mm) of the heater outlet and upstream of the draft hood on units so equipped. Locate one thermocouple in the center of the pipe and eight thermocouples along imaginary lines intersecting at right angles in this horizontal plane at points one third and two thirds of the distance between the center of the pipe and the pipe wall.

For units which employ direct vent systems that significantly preheat the incoming combustion air, install nine thermocouples, wired in parallel, in a plane parallel to and located within 6 inches (152.4 mm) of the vent/air intake terminal. Equalize the length of all thermocouple leads before paralleling. Locate one thermocouple in the center of the vent pipe and eight thermocouples along imaginary lines intersecting at right angles in this plane at points one third and two thirds of the distance between the center of the flue pipe and the pipe wall.

Use bead-type thermocouples having wire size not greater than No. 24 American Wire Gauge (AWG). If there is a possibility that the thermocouples could receive direct radiation from the fire, install radiation shields on the fire side of the thermocouples only and position the shields so that they do not touch the thermocouple junctions.

Install thermocouples for measuring conditioned warm air temperature as described in ANSI Z21.49–1975, section 2.14. Establish the temperature of the inlet air by means of single No. 24 AWG bead-type thermocouple, suitably shielded from direct radiation and located in the center of the plane of each inlet air opening.

2.6.2 *Oil fueled vented home heating equipment (including direct vent systems).* Install nine thermocouples, wired in parallel and having equal length leads, in a plane perpendicular to the axis of the flue pipe. Locate this plane at the position shown in Figure 34.4 of UL 730–1974, or Figures 35.1 and 35.2 of UL 729–1976 for a single thermocouple, except that on direct vent systems which significantly preheat the incoming combustion air, it shall be located within 6 inches (152.5 mm) of the outlet of the vent/air intake terminal. Locate one thermocouple in the center of the flue pipe and eight thermocouples along imaginary lines intersecting at right angles in this plane at points one third and two thirds of the distance between the center of the pipe and pipe wall.

Use bead-type thermocouples having a wire size not greater than No. 24 AWG. If there is a possibility that the thermocouples could receive direct radiation from the fire, install radiation shields on the fire side of the thermocouples only and position the shields so that they do not touch the thermocouple junctions.

Install thermocouples for measuring the conditioned warm air temperature as described in sections 35.12 through 35.17 of UL 730–1974. Establish the temperature of the inlet air by means of a single No. 24 AWG bead-type thermocouple, suitably shielded from direct radiation and located in the center of the plane of each inlet air opening.

2.7 *Combustion measurement instrumentation.* Analyze the samples of stack and flue gases for vented heaters to determine the concentration by volume of carbon dioxide present in the dry gas with instrumentation which will result in a reading having an accuracy of ±0.1 percentage points.

2.8 *Energy flow instrumentation.* Install one or more instruments, which measure the rate of gas flow or fuel oil supplied to the vented heater, and if appropriate, the electrical energy with an error no greater than one percent.

2.9 *Room ambient temperature.* During the time period required to perform all the testing and measurement procedures specified in section 3.0 of this appendix, maintain the room temperature within ±5° F (±2.8C) of the value T_{RA} measured during the steady-state performance test. At no time during these tests shall the room temperature exceed 100° F (37.8C) or fall below 65° F (18.3C).

Temperature (T_{RA}) shall be the arithmetic average temperature of the test area, determined by measurement with four No. 24 AWG bead-type thermocouples with junctions shielded against radiation, located approximately at 90-degree positions on a circle circumscribing the heater or heater enclosure under test, in a horizontal plane approximately at the vertical midpoint of the appliance or test enclosure, and with the junctions approximately 24 inches from sides of the heater or test enclosure and located so as not to be affected by other than room air. Locate a thermocouple at each elevation of draft relief inlet opening and combustion air inlet opening at a distance of approximately 24 inches from the inlet openings. The temperature of the air for combustion and the air for draft relief shall not differ more than ±5° F from room temperature as measured above.

2.10 *Equipment used to measure mass flow rate in flue and stack.* The tracer gas chosen for this task should have a density which is less than or approximately equal to the density of air. Use a gas unreactive with the environment to be encountered. Using instrumentation of either the batch or continuous type, measure the concentration of tracer gas with an error no greater than 2 percent of the value of the concentration measured.

3.0 *Testing and measurements.*

3.1 *Steady-state testing.*

3.1.1 *Gas fueled vented home heating equipment (including direct vent systems).* Set up the vented heater as specified in sections 2.1, 2.2, and 2.3 of this appendix. The draft diverter shall be in the normal open condition and the stack shall not be insulated. (Insulation of the stack is no longer required for the vented heater test.) Begin the steady-state performance test by operating the burner and the circulating air blower, on units so equipped, with the adjustments specified by sections 2.4.1 and 2.5 of this appendix, until steady-state conditions are attained as indicated by a temperature variation of not more than 3°F (1.7 C) in the stack gas temperature for vented heaters equipped with draft diverters or 5°F (2.8 C) in the flue gas temperature for vented heaters equipped with either draft hoods or direct vent systems; in three successive readings taken 15 minutes apart.

On units employing draft diverters, measure the room temperature (T_{RA}) as described in section 2.9 of this appendix and measure the steady-state stack gas temperature ($T_{S,SS}$) using the nine thermocouples located in the 5 foot test stack as specified in section 2.6.1 of this appendix. Secure a sample of the stack gases in the plane where $T_{S,SS}$ is measured or within 3.5 feet downstream of this plane. Determine the concentration by volume of carbon dioxide (X_{CO2S}) present in the dry stack gas. If the location of the gas sampling differs from the temperature measurement plane, there shall be no air leaks through the stack between these two locations.

On units employing draft hoods or direct vent systems, measure the room temperature (T_{RA}) as described in section 2.9 of this appendix and measure the steady-state flue gas temperature ($T_{F,SS}$), using the nine thermocouples located in the flue pipe as described in section 2.6.1 of this appendix. Secure a sample of the flue gas in the plane of temperature measurement and determine the concentration by volume of CO_2 (X_{CO2F}) present in dry flue gas. In addition, for units employing draft hoods, secure a sample of the stack gas in a horizontal plane in the five foot test stack located one foot from the test stack inlet; and determine the concentration by volume of CO_2 (X_{CO2S}) present in dry stack gas.

Determine the steady-state heat input rate (Q_{in}) including pilot gas by multiplying the measured higher heating value of the test gas by the steady-state gas input rate corrected to standard conditions of 60°F and 30 inches of mercury. Use measured values of gas temperature and pressure at the meter and the barometric pressure to correct the metered gas flow rate to standard conditions.

After the above test measurements have been completed on units employing draft diverters, secure a sample of the flue gases at the exit of the heat exchanger(s) and determine the concentration of CO_2 (X_{CO2F}) present. In obtaining this sample of flue gas, move the sampling probe around or use a sample probe with multiple sampling ports in order to assure that an average value is obtained for the CO_2 concentration. For units with multiple heat exchanger outlets, measure the CO_2 concentration in a sample from each outlet to obtain the average CO_2 concentration for the unit. A manifold (parallel connected sampling tubes) may be used to obtain this sample.

For heaters with single stage thermostat control (wall mounted electric thermostats), determine the steady-state efficiency at the maximum fuel input rate as specified in section 2.4 of this appendix.

For gas fueled vented heaters equipped with either two stage thermostats or step-modulating thermostats, determine the steady-state efficiency at the maximum fuel input rate, as specified in section 2.4.1 of this appendix, and at the reduced fuel input rate, as specified in section 2.4.1 of this appendix.

For manually controlled gas fueled vented heaters, with various input rates determine the steady-state efficiency at a fuel input rate that is within ±5 percent of 50 percent of the maximum fuel input rate. If the heater is designed to use a control that precludes operation at other than maximum output (single firing rate) determine the steady state efficiency at the maximum input rate only.

3.1.2 *Oil fueled vented home heating equipment (including direct vent systems).* Set up and adjust the vented heater as specified in sections 2.1, 2.2, and 2.3.4 of this appendix. Begin the steady-state performance test by operating the burner and the circulating air blower, on units so equipped, with the adjustments specified by sections 2.4.2 and 2.5 of this appendix until steady-state conditions are attained as indicated by a temperature variation of not more than 5°F (2.8 C) in the flue gas temperature in three successive readings taken 15 minutes apart.

Do not allow smoke in the flue, for units equipped with power burners, to exceed a No. 1 smoke during the steady-state performance test as measured by the procedure described in ANSI standard Z11.182–1965 (R1971) (ASTM D 2156–65

(1970)). Maintain the average draft over the fire and in the breeching during the steady-state performance test at that recommended by the manufacturer ±0.005 inches of water gauge.

Measure the room temperature (T_{RA}) as described in section 2.9 of this appendix and measure the steady-state flue gas temperature ($T_{F,SS}$) using nine thermocouples located in the flue pipe as described in section 2.6.2 of this appendix. Secure a sample of the flue gas in the plane of temperature measurement and determine the concentration by volume of CO_2(X_{CO2F}) present in dry flue gas. Measure and record the steady-state heat input rate (Q_{in}).

For manually controlled oil fueled vented heaters, determine the steady-state efficiency at a fuel input rate that is within ±5 percent of 50 percent of the maximum fuel input rate.

3.1.3 *Auxiliary Electric Power Measurement.* Allow the auxiliary electrical system of a gas or oil vented heater to operate for at least five minutes before recording the maximum auxiliary electric power measurement from the wattmeter. Record the maximum electric power (P_E) expressed in kilowatts. For vented heaters with modulating controls, the recorded (P_E) shall be maximum measured electric power multiplied by the following factor (R). For two stage controls, R=1.3. For step modulating controls, R=1.4 when the ratio of minimum-to-maximum fuel input is greater than or equal to 0.7, R=1.7 when the ratio of minimum-to-maximum fuel input is less than 0.7 and greater than or equal to 0.5, and R=2.2 when the ratio of minimum-to-maximum fuel input is less than 0.5.

3.2 *Jacket loss measurement.* Conduct a jacket loss test for vented floor furnaces. Measure the jacket loss (L_j) in accordance with the ANSI standard Z21.48–1976 section 2.12.

3.3 *Measurement of the off-cycle losses for vented heaters equipped with thermal stack dampers.* Install the thermal stack damper according to the manufacturer's instructions. Unless specified otherwise, the thermal stack damper should be at the draft diverter exit collar. Attach a five foot length of bare stack to the outlet of the damper. Install thermocouples as specified in section 2.6.1 of this appendix.

For vented heaters equipped with single stage thermostats, measure the off-cycle losses at the maximum fuel input rate. For vented heaters equipped with two stage thermostats, measure the off-cycle losses at the maximum fuel input rate and at the reduced fuel input rate. For vented heaters equipped with step-modulating thermostats, measure the off-cycle losses at the reduced fuel input rate.

Let the vented heater heat up to a steady-state condition. Feed a tracer gas at a constant metered rate into the stack directly above and within one foot above the stack damper. Record tracer gas flow rate and temperature. Measure the tracer gas concentration in the stack at several locations in a horizontal plane through a cross section of the stack at a point sufficiently above the stack damper to ensure that the tracer gas is well mixed in the stack.

Continuously measure the tracer gas concentration and temperature during a 10 minute cool down period. Shut the burner off and immediately begin measuring tracer gas concentration in the stack, stack temperature, room temperature, and barometric pressure. Record these values as the midpoint of each one-minute interval between burner shut down and ten minutes after burner shut down. Meter response time and sampling delay time shall be considered in timing these measurements.

3.4 *Measurement of the effectiveness of electro-mechanical stack dampers.* For vented heaters equipped with electro-mechanical stack dampers, measure the cross sectional area of the stack (A_s), the net area of the damper plate (A_o), and the angle that the damper plate makes when closed with a plane perpendicular to the axis of the stack (Ω). The net area of the damper plate means the area of the damper plate minus the area of any holes through the damper plate.

3.5 *Pilot light measurement.* Measure the energy input rate to the pilot light (Q_p) with an error no greater than 3 percent for vented heaters so equipped.

3.6 *Optional procedure for determining* D_p, D_F, and D_s *for systems for all types of vented heaters.* For all types of vented heaters, D_p, D_F, and D_s can be measured by the following optional cool down test.

Conduct a cool down test by letting the unit heat up until steady-state conditions are reached, as indicated by temperature variation of not more than 5°F (2.8°C) in the flue gas temperature in three successive readings taken 15 minutes apart, and then shutting the unit off with the stack or flue damper controls by-passed or adjusted so that the stack or flue damper remains open during the resulting cool down period. If a draft was maintained on oil fueled units in the flue pipe during the steady-state performance test described in section 3.1 of this appendix, maintain the same draft (within a range of −.001 to +.005 inches of water gauge of the average steady-state draft) during this cool down period.

Measure the flue gas mass flow rate ($m_{F,OFF}$) during the cool down test described above at a specific off-period flue gas temperature and corrected to obtain its value at the steady-state flue gas temperature ($T_{F,SS}$), using the procedure described below.

Within one minute after the unit is shut off to start the cool down test for determining D_P, begin feeding a tracer gas into the combustion chamber at a constant flow rate of V_T, and at a point which will allow for the best possible mixing with the air flowing through the chamber. (On units equipped with an oil fired power burner, the best location for injecting this tracer gas appears to be through a hole drilled in the air tube.) Periodically measure the value of V_T with an instantaneously reading flow meter having an accuracy of ±3 percent of the quantity measured. Maintain V_T at less than 1 percent of the air flow rate through the furnace. If a combustible tracer gas is used, there should be a delay period between the time the burner gas is shut off and the time the tracer gas is first injected to prevent ignition of the tracer gas.

Between 5 and 6 minutes after the unit is shut off to start the cool down test, measure at the exit of the heat exchanger the average flue gas temperature, $T^*_{F,OFF}$. At the same instant the flue gas temperature is measured, also measure the percent volumetric concentration of tracer gas C_T in the flue gas in the same plane where $T^*_{F,OFF}$ is determined. Obtain the concentration of tracer gas using an instrument which will result in an accuracy of ±2 percent in the value of C_T measured. If use of a continuous reading type instrument results in a delay time between drawing of a sample and its analysis, this delay should be taken into account so that the temperature measurement and the measurement of tracer gas concentration coincide. In addition, determine the temperature of the tracer gas entering the flow meter (T_T) and the barometric pressure (P_B).

The rate of the flue gas mass flow through the vented heater and the factors D_P, D_F, and D_s are calculated by the equations in sections 4.5.1 through 4.5.3 of this appendix.

4.0 *Calculations.*

4.1 *Annual fuel utilization efficiency for gas or oil fueled vented home heating equipment equipped without manual controls and without thermal stack dampers.* The following procedure determines the annual fuel utilization efficiency for gas or oil fueled vented home heating equipment equipped without manual controls and without thermal stack dampers.

4.1.1 *System number.* Obtain the system number from Table 1 of this appendix.

4.1.2 *Off-cycle flue gas draft factor.* Based on the system number, determine the off-cycle flue gas draft factor (D_F) from Table 1 of this appendix.

4.1.3 *Off-cycle stack gas draft factor.* Based on the system number, determine the off-cycle stack gas draft factor (D_s) from Table 1 of this appendix.

4.1.4 *Pilot fraction.* Calculate the pilot fraction (P_F) expressed as a decimal and defined as:

$$P_F = Q_P / Q_{in}$$

where:

Q_P = as defined in 3.5 of this appendix
Q_{in} = as defined in 3.1 of this appendix at the maximum fuel input rate

4.1.5 *Jacket loss for floor furnaces.* Determine the jacket loss (L_j) expressed as a percent and measured in accordance with section 3.2 of this appendix. For other vented heaters L_j=0.0.

4.1.6 *Latent heat loss.* Based on the fuel, obtain the latent heat loss ($L_{L,A}$) from Table 2 of this appendix.

4.1.7 *Ratio of combustion air mass flow rate to stoichiometric air mass flow rate.* Determine the ratio of combustion air mass flow rate to stoichiometric air mass flow rate ($R_{T,F}$), and defined as:

$$R_{T,F} = A + B / X_{CO2F}$$

where:

A = as determined from Table 2 of this appendix
B = as determined from Table 2 of this appendix
X_{CO2F} = as defined in 3.1 of this appendix

4.1.8 *Ratio of combustion and relief air mass flow rate to stoichiometric air mass flow rate.* For vented heaters equipped with either an integral draft diverter or a drafthood, determine the ratio of combustion and relief air mass flow rate to stoichiometric air mass flow rate ($R_{T,S}$), and defined as:

$$R_{T,S}=A+[B/X_{CO_2S}]$$

where:

A = as determined from Table 2 of this appendix
B = as determined from Table 2 of this appendix
X_{CO_2S} = as defined in 3.1 of this appendix

4.1.9 *Sensible heat loss at steady-state operation.* For vented heaters equipped with either an integral draft diverter or a draft hood, determine the sensible heat loss at steady-state operation ($L_{S,SS,A}$) expressed as a percent and defined as:

where:

$$L_{S,SS,A}=C(R_{T,S}+D)(T_{S,SS}-T_{RA})$$

C = as determined from Table 2 of this appendix
$R_{T,S}$ = as defined in 4.1.8 of this appendix
D = as determined from Table 2 of this appendix
$T_{S,SS}$ = as defined in 3.1 of this appendix
T_{RA} = as defined in 2.9 of this appendix

For vented heaters equipped without an integral draft diverter, determine ($L_{S,SS,A}$) expressed as a percent and defined as:

$$L_{S,SS,A}=C(R_{T,F}+D)(T_{F,SS}-T_{RA})$$

where:

C = as determined from Table 2 of this appendix
$R_{T,F}$ = as defined in 4.1.7 of this appendix
D = as determined from Table 2 of this appendix
$T_{F,SS}$ = as defined in 3.1 of this appendix
T_{RA} = as defined in 2.9 of this appendix

4.1.10 *Steady-state efficiency.* For vented heaters equipped with single stage thermostats, calculate the steady-state efficiency (excluding jacket loss, η_{SS}, expressed in percent and defined as:

$$\eta_{SS}=100-L_{L,A}-L_{S,SS,A}$$

where:

$L_{L,A}$ = as defined in 4.1.6 of this appendix
$L_{S,SS,A}$ = as defined in 4.1.9 of this appendix

For vented heaters equipped with either two stage thermostats or with step-modulating thermostats, calculate the steady-state efficiency at the reduced fuel input rate, η_{SS}-L, expressed in percent and defined as:

$$\eta_{SS-L}=100-L_{L,A}-L_{S,SS,A}$$

where:

$L_{L,A}$ = as defined in 4.1.6 of this appendix
$L_{S,SS,A}$ = as defined in 4.1.9 of this appendix in which $L_{S,SS,A}$ is determined at the reduced fuel input rate

For vented heaters equipped with two stage thermostats, calculate the steady-state efficiency at the maximum fuel input rate, η_{SS-H}, expressed in percent and defined as:

$$\eta_{SS-H}=100-L_{L,A}-L_{S,SS,A}$$

where:

$L_{L,A}$ = as defined in 4.1.6 of this appendix
$L_{S,SS,A}$ = as defined in 4.1.9 of this appendix in which $L_{S,SS,A}$ is measured at the maximum fuel input rate

For vented heaters equipped with step-modulating thermostats calculate the weighted-average steady-state efficiency in the modulating mode, η_{SS-MOD}, expressed in percent and defined as:

$$\eta_{SS-MOD}=[\eta_{SS-H}-\eta_{SS-L}]\left[\frac{T_C-T_{OA^*}}{T_C-15}\right]+\eta_{SS-L}$$

where:

η_{SS-H} = as defined in 4.1.10 of this appendix
η_{SS-L} = as defined in 4.1.10 of this appendix
T_{OA^*} = average outdoor temperature for vented heaters with step-modulating thermostats operating in the modulating mode and is obtained from Table 3 or Figure 1 of this appendix
T_C = balance point temperature which represents a temperature used to apportion the annual heating load between the reduced input cycling mode and either the modulating mode or maximum input cycling mode and is obtained either from Table 3 of this appendix or calculated by the following equation:

$$T_C=65-[(65-15)R]$$

where:

65 = average outdoor temperature at which a vented heater starts operating
15 = national average outdoor design temperature for vented heaters
R = ratio of reduced to maximum heat output rates, as defined in 4.1.13 of this appendix

4.1.11 *Reduced heat output rate.* For vented heaters equipped with either two stage thermostats or step-modulating thermostats, calculate the reduced heat output rate ($Q_{red\text{-}out}$) defined as:

$$Q_{red\text{-}out}=\eta_{SS-L}Q_{red\text{-}in}$$

where:

η_{SS-L} = as defined in 4.1.10 of this appendix
$Q_{red\text{-}in}$ = the reduced fuel input rate

4.1.12 *Maximum heat output rate.* For vented heaters equipped with either two stage thermostats or step-modulating thermostas, calculate the maximum heat output rate ($Q_{max\text{-}out}$) defined as:

$$Q_{max,\ out}=\eta_{SS,H}\ Q_{max,\ in}$$

where:

η_{SS-H} = as defined in 4.1.10 of this appendix
$Q_{max\text{-}in}$ = the maximum fuel input rate

4.1.13 *Ratio of reduced to maximum heat output rates.* For vented heaters equipped with either two stage thermostats or step-modulating thermostats, calculate the ratio of reduced to maximum heat output rates (R) expressed as a decimal and defined as:

$$R=Q_{red\text{-}out}/Q_{max\text{-}out}$$

where:

$Q_{red\text{-}out}$ = as defined in 4.1.11 of this appendix
$Q_{max\text{-}out}$ = as defined in 4.1.12 of this appendix

4.1.14 *Fraction of heating load at reduced operating mode.* For vented heaters equipped with either two stage thermostats or step-modulating thermostats, determine the fraction of heating load at the reduced operating mode (X_1) expressed as a decimal and listed in Table 3 of this appendix or obtained from Figure 2 of this appendix.

4.1.15 *Fraction of heating load at maximum operating mode or noncycling mode.* For vented heaters equipped with either two stage thermostats or step-modulating therostats, determine the fraction of heating load at the maximum operating mode or noncycling mode (X_2) expressed as a decimal and listed in Table 3 of this appendix or obtained from Figure 2 of this appendix.

4.1.16 *Weighted-average steady-state efficiency.* For vented heaters equipped with single stage thermostats, the weighted-average steady-state efficiency (η_{SS-WT}) is equal to η_{SS}, as defined in section 4.1.10 of this appendix. For vented heaters equipped with two stage thermostats, η_{SS-WT} is defined as:

$$\eta_{SS-WT}=X_1\eta_{SS-L}+X_2\eta_{SS-H}$$

where:

X_1 = as defined in 4.1.14 of this appendix
η_{SS-L} = as defined in 4.1.10 of this appendix
X_2 = as defined in 4.1.15 of this appendix
η_{SS-H} = as defined in 4.1.10 of this appendix

For vented heaters equipped with step-modulating thermostats, η_{SS-WT} is defined as:

$$\eta_{SS-WT}=X_1\eta_{SS-L}+X_2\eta_{SS-MOD}$$

where:

X_1 = as defined in 4.1.14 of this appendix
η_{SS-L} = as defined in 4.1.10 of this appendix
X_2 = as defined in 4.1.15 of this appendix
η_{SS-MOD} = as defined in 4.1.10 of this appendix

4.1.17 *Annual fuel utilization efficiency.* Calculate the annual fuel utilization efficiency (AFUE) expressed as percent and defined as:

$$AFUE=[0.968\eta_{SS-WT}]-1.78D_F-1.89D_S-129P_F-2.8\ L_J+1.81$$

where:

η_{SS-WT} = as defined in 4.1.16 of this appendix
D_F = as defined in 4.1.2 of this appendix
D_S = as defined in 4.1.3 of this appendix
P_F = as defined in 4.1.4 of this appendix
L_J = as defined in 4.1.5 of this appendix

4.2 *Annual fuel utilization efficiency for gas or oil fueled vented home heating equipment equipped with manual controls.* The following procedure determines the annual fuel utilization efficiency for gas or oil fueled vented home heating equipment equipped with manual controls.

4.2.1 *Average ratio of stack gas mass flow rate to flue gas mass flow rate at steady-state operation.* For vented heaters equipped with either direct vents or direct exhaust or are outdoor units, the average ratio of stack gas mass flow rate to flue gas mass flow rate at steady-state operation (S/F) shall be equal to unity. (S/F=1.) For all other types of vented heaters, calculate (S/F) defined as:

$$S/F=1.3R_{T,S}/R_{T,F}$$

where:

$R_{T,S}$ = as defined in 4.1.8 of this appendix with X_{CO2S} measured at 50% fuel input rate

$R_{T,F}$ = as defined in 4.1.7 of this appendix with X_{CO2F} measured at 50% fuel input rate

4.2.2 *Multiplication factor for infiltration loss during burner on-cycle.* Calculate the multiplication factor for infiltration loss during burner on-cycle ($K_{I,ON}$) defined as:

$K_{I,ON} = 100(0.24)(S/F)(0.7)[1 + R_{T,F}(A/F)]/HHV_A$

where:

100 = converts a decimal fraction into a percent

0.24 = specific heat of air

A/F = stoichiometric air/fuel ratio, determined in accordance with Table 2 of this appendix

S/F = as defined in 4.2.1 of this appendix at 50 percent of rated maximum fuel input

0.7 = infiltration parameter

$R_{T,F}$ = as defined in 4.1.7 of this appendix

HHV_A = average higher heating value of the test fuel, determined in accordance with Table 2 of this appendix

4.2.3 *On-cycle infiltration heat loss.* Calculate the on-cycle infiltration heat loss ($L_{I,ON}$) expressed as a percent and defined as:

$L_{I,ON} = K_{I,ON}(70-45)$

where:

$K_{I,ON}$ = as defined in 4.2.2 of this appendix

70 = average indoor temperature

45 = average outdoor temperature

4.2.4 *Weighted-Average Steady-State Efficiency.* For manually controlled heaters with various input rates the weighted average steady-state efficiency ($\eta_{SS\text{-}WT}$), is at 50 percent of the maximum fuel input rate as measured in either section 3.1.1 to this appendix for manually controlled gas vented heaters or section 3.1.2 to this appendix for manually controlled oil vented heaters. For manually controlled heater with one single firing rate the weighted average steady-state efficiency is the steady state efficiency measured at the single firing rate.

4.2.5 *Part-load fuel utilization efficiency.* Calculate the part-load fuel utilization efficiency (η_u) expressed as a percent and defined as:

$\eta_u = \eta_{SS\text{-}WT} - L_{I,ON}$

where:

$\eta_{SS\text{-}WT}$ = as defined in 4.2.4 of this appendix

$L_{I,ON}$ = as defined in 4.2.3 of this appendix

4.2.6 *Annual fuel utilization efficiency.* For manually controlled vented heaters. Calculate the annual fuel utilization efficiency (AFUE) expressed as a percent and defined as:

$$AFUE = \frac{4400\eta_{SS}\eta_u Q_{in-max}}{4400\eta_{SS}Q_{in-max} + 2.5(4600)\eta_u Q_P}$$

where:

4400 = average number of heating degree days

η_{SS} = as defined as $\eta_{SS\text{-}WT}$ in 4.2.4 of this appendix

η_μ = as defined in 4.2.5 of this appendix

$Q_{in\text{-}max}$ = as defined as Q_{in} at the maximum fuel input rate, as defined in 3.1 of this appendix

4600 = average number of non-heating season hours per year

Q_p = as defined in 3.5 of this appendix

4.3 *Annual fuel utilization efficiency by the tracer gas method.* The annual fuel utilization efficiency shall be determined by the following tracer gas method for all vented heaters equipped with thermal stack dampers. All other types of vented heaters can elect to use the following tracer gas method, as an optional procedure.

4.3.1 *On-cycle sensible heat loss.* For vented heaters equipped with single stage thermostats, calculate the on-cycle sensible heat loss ($L_{S,ON}$) expressed as a percent and defined as:

$L_{S,ON} = L_{S,SS,A}$

where:

$L_{S,SS,A}$ = as defined in 4.1.9 of this appendix

For vented heaters equipped with two stage thermostats, calculate $L_{S,ON}$ defined as:

$L_{S,ON} = X_1 L_{S,SS,A\text{-}red} + X_2 L_{S,SS,A\text{-}max}$

where:

X_1 = as defined in 4.1.14 of this appendix

$L_{S,SS,A\text{-}red}$ = as defined as $L_{S,SS,A}$ in 4.1.9 of this appendix at the reduced fuel input rate

X_2 = as defined in 4.1.15 of this appendix

$L_{S,SS,A\text{-}max}$ = as defined as $L_{S,SS,A}$ in 4.1.9 of this appendix at the maximum fuel input rate

For vented heaters with step-modulating thermostats, calculate $L_{S,ON}$ defined as:

$L_{S,ON} = X_1 L_{S,SS,A\text{-}red} + X_2 L_{S,SS,A\text{-}avg}$

where:

X_1 = as defined in 4.1.14 of this appendix

$L_{S,SS,A\text{-}red}$ = as defined in 4.3.1 of this appendix

X_2 = as defined in 4.1.15 of this appendix

$L_{S,SS,A\text{-}avg}$ = average sensible heat loss for step-modulating vented heaters operating in the modulating mode

$$L_{S,SS,A-avg} = \left[[L_{S,SS,A-max} - L_{S,SS,A-red}] \left[\frac{T_C - T_{OA^*}}{TC - 15} \right] \right] + L_{S,SS,A-red}$$

where:

$L_{S,SS,A\text{-}avg}$ = as defined in 4.3.1 of this appendix

T_C = as defined in 4.1.10 of this appendix

T_{OA^*} = as defined in 4.1.10 of this appendix

15 = as defined in 4.1.10 of this appendix

4.3.2 *On-cycle infiltration heat loss.* For vented heaters equipped with single stage thermostats, calculate the on-cycle infiltration heat loss ($L_{I,ON}$) expressed as a percent and defined as:

$L_{I,ON} = K_{I,ON}(70-45)$

where:

$K_{I,ON}$ = as defined in 4.2.2 of this appendix

70 = as defined in 4.2.3 of this appendix

45 = as defined in 4.2.3 of this appendix

For vented heaters equipped with two stage thermostats, calculate $L_{I,ON}$ defined as:

$L_{I,ON} = X_1 K_{I,ON\text{-}Max}(70-T_{OA^*}) + X_2 K_{I,ON,red}(70-T_{OA})$

where:

X_1 = as defined in 4.1.14 of this appendix

$K_{I,ON\text{-}max}$ = as defined as $K_{I,ON}$ in 4.2.2 of this appendix at the maximum heat input rate

70 = as defined in 4.2.3 of this appendix

T_{OA^*} = as defined in 4.3.4 of this appendix

$K_{I,ON,red}$ = as defined as $K_{I,ON}$ in 4.2.2 of this appendix at the minimum heat input rate

T_{OA} = as defined in 4.3.4 of this appendix

X_2 = as defined in 4.1.15 of this appendix

For vented heaters equipped with step-modulating thermostats, calculate $L_{I,ON}$ defined as:

$L_{I,ON} = X_1 K_{I,ON\text{-}avg}(70-T_{OA^*}) + X_2 K_{I,ON\text{-}red}(70-T_{OA})$

where:

X_1 = as defined in 4.1.14 of this appendix

$$K_{I,on\text{-}avg} = \frac{[K_{I,on\text{-}max} + K_{I,ON,red}]}{2}$$

70 = as defined in 4.2.3 of this appendix

T_{OA^*} = as defined in 4.3.4 of this appendix

X_2 = as defined in 4.1.15 of this appendix

T_{OA} = as defined in 4.3.4 of this appendix

4.3.3 *Off-cycle sensible heat loss.* For vented heaters equipped with single stage thermostats, calculate the off-cycle sensible heat loss ($L_{S,OFF}$) at the maximum fuel input rate. For vented heaters equipped with step-modulating thermostats, calculate $L_{S,OFF}$ defined as:

$L_{S,OFF} = X_1 L_{S,OFF,red}$

where:

X_1 = as defined in 4.1.14 of this appendix

$L_{S,OFF,red}$ = as defined as $L_{S,OFF}$ in 4.3.3 of this appendix at the reduced fuel input rate

For vented heaters equipped with two stage thermostats, calculate $L_{S,OFF}$ defined as:

$L_{S,OFF} = X_1 L_{S,OFF,red} + X_2 L_{S,OFF,Max}$

where:

X_1 = as defined in 4.1.14 of this appendix

$L_{S,OFF,red}$ = as defined as $L_{S,OFF}$ in 4.3.3 of this appendix at the reduced fuel input rate

X_2 = as defined in 4.1.15 of this appendix

$L_{S,OFF,Max}$ = as defined as $L_{S,OFF}$ in 4.3.3 of this appendix at the maximum fuel input rate

Calculate the off-cycle sensible heat loss ($L_{S,OFF}$) expressed as a percent and defined as:

$$L_{S.OFF}=\frac{100(0.24)}{Q_{in}t_{on}}\sum m_{S.OFF}(T_{S.OFF}-T_{RA})$$

where:

100 = conversion factor for percent

0.24 = specific heat of air in Btu per pound — °F

Q_{in} = fuel input rate, as defined in 3.1 of this appendix in Btu per minute (as appropriate for the firing rate)

t_{on} = average burner on-time per cycle and is 20 minutes

$\Sigma m_{S.OFF}(T_{S.OFF}-T_{RA})$ = summation of the twenty values of the quantity, $m_{S.OFF}(T_{S.OFF}-T_{RA})$, measured in accordance with 3.3 of this appendix

$m_{S.OFF}$ = stack gas mass flow rate pounds per minute

$$m_{S.OFF}=\frac{1.325P_BV_T(C_{T^*}-C_T)}{C_T(T_T+460)}$$

$T_{S.OFF}$ = stack gas temperature measured in accordance with 3.3 of this appendix

T_{RA} = average room temperature measured in accordance with 3.3 of this appendix

P_B = barometric pressure in inches of mercury

V_T = flow rate of the tracer gas through the stack in cubic feet per minute

C_{T^*} = concentration by volume of the active tracer gas in the mixture in percent and is 100 when the tracer gas is a single component gas

C_T = concentration by volume of the active tracer gas in the diluted stack gas in percent

T_T = temperature of the tracer gas entering the flow meter in degrees Fahrenheit

(T_T+460) = absolute temperature of the tracer gas entering the flow meter in degrees Rankine

4.3.4 *Average outdoor temperature.* For vented heaters equipped with single stage thermostats, the average outdoor temperature (T_{OA}) is 45°F. For vented heaters equipped with either two stage thermostats or step-modulating thermostats, T_{OA} during the reduced operating mode is obtained from Table 3 or Figure 1 of this appendix. For vented heaters equipped with two stage thermostats, T_{OA}^* during the maximum operating mode is obtained from Table 3 or Figure 1 of this appendix.

4.3.5 *Off-cycle infiltration heat loss.* For vented heaters equipped with single stage thermostats, calculate the off-cycle infiltration heat loss ($L_{I.OFF}$) at the maximum fuel input rate. For vented heaters equipped with step-modulating thermostats, calculate $L_{I.OFF}$ defined as:

$L_{I.OFF}=X_1L_{I.OFF.red}$

where:

X_1 = as defined in 4.1.14 of this appendix

$L_{I.OFF.red}$ = as defined in $L_{I.OFF}$ in 4.3.3 of this appendix at the reduced fuel input rate

For vented heaters equipped with two stage thermostats, calculate $L_{I.OFF}$ defined as:

$L_{I.OFF}=X_1L_{I.OFF.red}+X_2L_{I.OFF.max}$

where:

X_1 = as defined in 4.1.14 of this appendix

$L_{I.OFF.red}$ = as defined as $L_{I.OFF}$ in 4.3.3 of this appendix at the reduced fuel input rate

X_2 = as defined in 4.1.15 of this appendix

$L_{I.OFF.Max}$ = as defined as $L_{I.OFF}$ in 4.3.3 of this appendix at the maximum fuel input rate

Calculate the off-cycle infiltration heat loss ($L_{I.OFF}$) expressed as a percent and defined as:

$$L_{I.OFF}=\frac{100(0.24)(1.3)(0.7)(70-T_{OA})}{Q_{in}t_{on}}\sum m_{S.OFF}$$

where:

100 = conversion factor for percent

0.24 = specific heat of air in Btu per pound — °F

1.3 = dimensionless factor for converting laboratory measured stack flow to typical field conditions

0.7 = infiltration parameter

70 = assumed average indoor air temperature, °F

T_{OA} = average outdoor temperature as defined in 4.3.4 of this appendix

Q_{in} = fuel input rate, as defined in 3.1 of this appendix in Btu per minute (as appropriate for the firing rate)

t_{on} = average burner on-time per cycle and is 20 minutes

$\Sigma m_{S.OFF}$ = summation of the twenty values of the quantity, $m_{S.OFF}$, measured in accordance with 3.3 of this appendix

$m_{S.OFF}$ = as defined in 4.3.3 of this appendix

4.3.6 *Part-load fuel utilization efficiency.* Calculate the part-load fuel utilization efficiency (η_u) expressed as a percent and defined as:

$$\eta_u=100-L_{L.A}-C_jL_j-\left[\frac{t_{on}}{t_{on}+P_Ft_{OFF}}\right]+[L_{S.ON}+L_{S.OFF}+L_{I.ON}+L_{I.OFF}]$$

where:

C_j = 2.8, adjustment factor

L_j = jacket loss as defined in 4.1.5

$L_{L.A}$ = as defined in 4.1.6 of this appendix

t_{on} = as defined in 4.3.3 of this appendix

$L_{S.ON}$ = as defined in 4.3.1 of this appendix

$L_{S.OFF}$ = as defined in 4.3.3 of this appendix

$L_{I.ON}$ = as defined in 4.3.2 of this appendix

$L_{I.OFF}$ = as defined in 4.1.4 of this appendix

P_F = as defined in 4.1.4 of this appendix

t_{OFF} = average burner off-time per cycle and is 20 minutes

4.3.7 *Annual fuel utilization efficiency.* Calculate the annual fuel utilization efficiency (AFUE) expressed as a percent and defined as:

$$AFUE=\frac{4400\eta_{SS-WT}\eta_uQ_{in-max}}{4400\eta_{SS}Q_{in-max}+2.5(4600)\eta_uQ_p}$$

where:

4400 = as defined in 4.2.6

η_{SS-WT} = as defined in 4.1.16 of this appendix

η_u = as defined in 4.3.6 of this appendix

Q_{in-max} = as defined in 4.2.6 of this appendix

4600 = as defined in 4.2.6 of this appendix

Q_p = as defined in 3.5 of this appendix

4.4 *Stack damper effectiveness for vented heaters equipped with electro-mechanical stack dampers.* Determine the stack damper effectiveness for vented heaters equipped with electro-mechanical stack dampers (D_o), defined as:

$D_o=1.62\,[1-A_D\cos\Omega/A_S]$

where:

A_D = as defined in 3.4 of this appendix

Ω = as defined in 3.4 of this appendix

A_S = as defined in 3.4 of this appendix

4.5 *Addition requirements for vented home heating equipment using indoor air for combustion and draft control.* For vented home heating equipment using indoor air for combustion and draft control, D_F, as described in section 4.1.2 of this appendix, and D_S, as described in section 4.1.3 of this appendix, shall be determined from Table 1 of this appendix.

4.5.1 *Optional procedure for determining D_P for vented home heating equipment.* Calculate the ratio (D_P) of the rate of flue gas mass through the vented heater during the off-period, $M_{F.OFF}(T_{F.SS})$, to the rate of flue gas mass flow during the on-period, $M_{F.SS}(T_{F.SS})$, and defined as:

$D_P=M_{F.OFF}(T_{F.SS})/M_{F.SS}(T_{F.SS})$

For vented heaters in which no draft is maintained during the steady-state or cool down tests, $M_{F.OFF}(T_{F.SS})$ is defined as:

$$M_{F.OFF}(T_{F.SS})=M_{F.OFF}(T^*_{F.OFF})\left[\frac{T_{F.SS}-T_{RA}}{T^*_{F.OFF}-T_{RA}}\right]^{0.56}\left[\frac{T^*_{F.OFF}+460}{T_{F.SS}+460}\right]^{1.19}$$

For oil fueled vented heaters in which an imposed draft is maintained, as described in section 3.6 of this appendix, $M_{F.OFF}(T_{F.SS})$ is defined as:

$M_{F.OFF}(T_{F.SS})=M_{F.OFF}(T^*_{F.SS})$

where:

$T_{F.SS}$ = as defined in 3.1.1 of this appendix

$T^*_{F.OFF}$ = flue gas temperature during the off-period measured in accordance with 3.6 of this appendix in degrees Fahrenheit

T_{RA} = as defined in 2.9 of this appendix

$$M_{F,OFF}(T_{F,OFF}) = \frac{1.325\ P_B V_T(100 - C_T)}{C_T(T_T + 460)}$$

p_B = barometric pressure measured in accordance with 3.6 of this appendix in inches of mercury
V_T = flow rate of tracer gas through the vented heater measured in accordance with 3.6 of this appendix in cubic feet per minute
C_T = concentration by volume of tracer gas present in the flue gas sample measured in accordance with 3.6 of this appendix in percent
C_T^* = concentration by volume of the active tracer gas in the mixture in percent and is 100 when the tracer gas is a single component gas
T_T = the temperature of the tracer gas entering the flow meter measured in accordance with 3.6 of this appendix in degrees Fahrenheit
$(T_T + 460)$ = absolute temperature of the tracer gas entering the flow meter in degrees Rankine
$M_{F,SS}(T_{F,SS}) = Q_{in}[R_{T,F}(A/F) + 1]/[60 HHV_A]$
Q_{in} = as defined in 3.1 of this appendix
$R_{T,F}$ = as defined in 4.1.7 of this appendix
A/F = as defined in 4.2.2 of this appendix
HHV_A = as defined in 4.2.2 of this appendix

4.5.2 *Optional procedure for determining off-cycle draft factor for flue gas flow for vented heaters.* For systems numbered 1 thru 10, calculate the off-cycle draft factor for flue gas flow (D_F) defined as:

$D_F = D_P$

For systems numbered 11 or 12: $D_F = D_P D_O$

where:

D_P = as defined in 4.5.1. of this appendix
D_O = as defined in 4.4 of this appendix

4.5.3 *Optional procedure for determining off-cycle draft factor for stack gas flow for vented heaters.* Calculate the off-cycle draft factor for stack gas flow (D_S) defined as:

For systems numbered 1 or 2: $D_S = 1.0$
For systems numbered 3 or 4: $D_S = (D_P + 0.79)/1.4$
For systems numbered 5 or 6: $D_S = D_O$
For systems numbered 7 or 8 and if $D_O(S/F) < 1$: $D_S = D_O D_P$
For systems numbered 7 or 8 and if $D_O(S/F) > 1$:

$D_S = D_O D_P + [0.85 - D_O D_P]\,[D_O(S/F) - 1]/[S/F - 1]$

where:

D_P = as defined in 4.5.1 of this appendix
D_O = as defined in 4.4 of this appendix

TABLE 1.—OFF-CYCLE DRAFT FACTORS FOR FLUE GAS FLOW (D_F) AND FOR STACK GAS FLOW (D_S) FOR VENTED HOME HEATING EQUIPMENT EQUIPPED WITHOUT THERMAL STACK DAMPERS

System number	(D_F)	(D_S)	Burner type	Venting system type [1]
1	1.0	1.0	Atmospheric.	Draft hood or diverter.
2	0.4	1.0	Power	Draft hood or diverter.
3	1.0	1.0	Atmospheric.	Barometric draft regulator.
4	0.4	0.85	Power	Barometric draft regulator.
5	1.0	D_o	Atmospheric.	Draft hood or diverter with damper.
6	0.4	D_o	Power	Draft hood or diverter with damper.
7	1.0	D_o	Atmospheric.	Barometric draft regulator with damper.
8	0.4	$D_o D_p$	Power	Barometric draft regulator with damper.
9	1.0		Atmospheric.	Direct vent.
10	0.4		Power	Direct vent.
11	D_o		Atmospheric.	Direct vent with damper.
12	0.4 D_o		Power	Direct vent with damper.

[1] Venting systems listed with dampers means electro-mechanical dampers only.

TABLE 2.—VALUES OF HIGHER HEATING VALUE ($HHV_{(A)}$), STOICHIOMETRIC AIR/FUEL (A/F), LATENT HEAT LOSS ($L_{L,A}$) AND FUEL-SPECIFIED PARAMETERS (A, B, C, AND D) FOR TYPICAL FUELS

Fuels	HHV_A (Btu/lb)	A/F	$L_{L,A}$	A	B	C	D
No. 1 oil	19,800	14.56	6.55	0.0679	14.22	0.0179	0.167
No. 2 oil	19,500	14.49	6.50	0.0667	14.34	0.0181	0.167
Natural gas	20,120	14.45	9.55	0.0919	10.96	0.0175	0.171
Manufactured gas	18,500	11.81	10.14	0.0965	10.10	0.0155	0.235
Propane	21,500	15.58	7.99	0.0841	12.60	0.0177	0.151
Butane	20,000	15.36	7.79	0.0808	12.93	0.0180	0.143

TABLE 3.—FRACTION OF HEATING LOAD AT REDUCED OPERATING MODE (X1) AND AT MAXIMUM OPERATING MODE (X2), AVERAGE OUTDOOR TEMPERATURES (TOA AND TOA*), AND BALANCE POINT TEMPERATURE (TC) FOR VENTED HEATERS EQUIPPED WITH EITHER TWO-STAGE THERMOSTATS OR STEP-MODULATING THERMOSTATS

TABLE 3.—FRACTION OF HEATING LOAD AT REDUCED OPERATING MODE (X1) AND AT MAXIMUM OPERATING MODE (X2), AVERAGE OUTDOOR TEMPERATURES (TOA AND TOA*), AND BALANCE POINT TEMPERATURE (TC) FOR VENTED HEATERS EQUIPPED WITH EITHER TWO-STAGE THERMOSTATS OR STEP-MODULATING THERMOSTATS—Continued

Heat output ratio [a]	X1	X2	TOA	TOA*	TC
0.20 to 0.24	.12	.88	57	40	53
0.25 to 0.29	.16	.84	56	39	51
0.30 to 0.34	.20	.80	54	38	49
0.35 to 0.39	.30	.70	53	36	46
0.40 to 0.44	.36	.64	52	35	44
0.45 to 0.49	.43	.57	51	34	42
0.50 to 0.54	.52	.48	50	32	39
0.55 to 0.59	.60	.40	49	30	37
0.60 to 0.64	.70	.30	48	29	34
0.65 to 0.69	.76	.24	47	27	32
0.70 to 0.74	.84	.16	46	25	29
0.75 to 0.79	.88	.12	46	22	27
0.80 to 0.84	.94	.06	45	20	23
0.85 to 0.89	.96	.04	45	18	21
0.90 to 0.94	.98	.02	44	16	19
0.95 to 0.99	.99	.01	44	13	17

[a] The heat output ratio means the ratio of minimum to maximum heat output rates as defined in 4.1.13.

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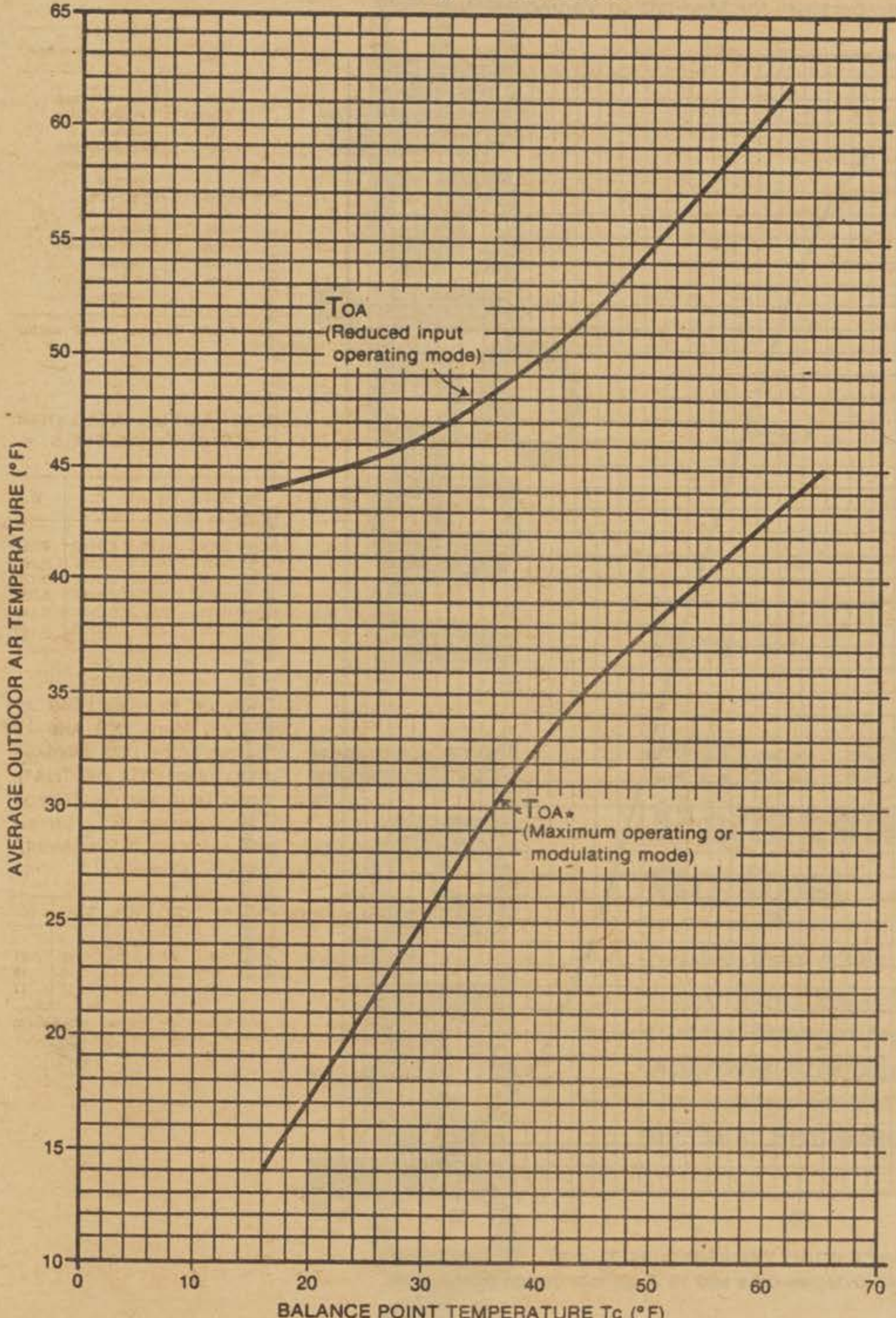
FIGURE 1

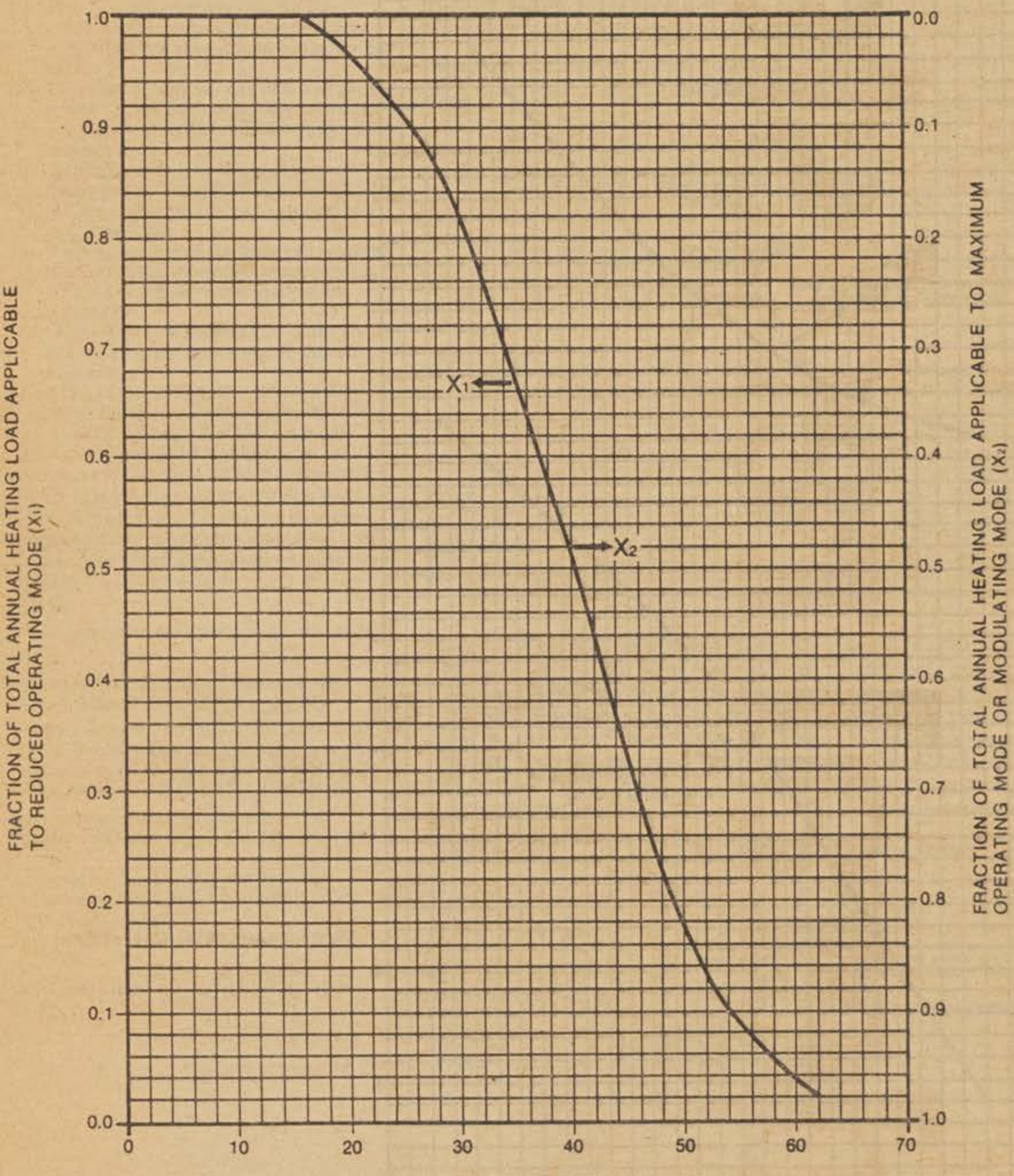
Average Outdoor Air Temperature vs. Balance Point Temperature for Modulating Vented Heaters



This figure is based on 4500 degree-days and 15°F outdoor design temperature.

FIGURE 2

Fraction of Total Annual Heating Load Applicable to Reduced Operating Mode (X_1) and to Maximum Operating Mode or Modulating Mode (X_2) vs. Balance Point Temperature for Modulating Vented Heaters



This figure is based on 4500 degree-days and 15°F outdoor design temperature.

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